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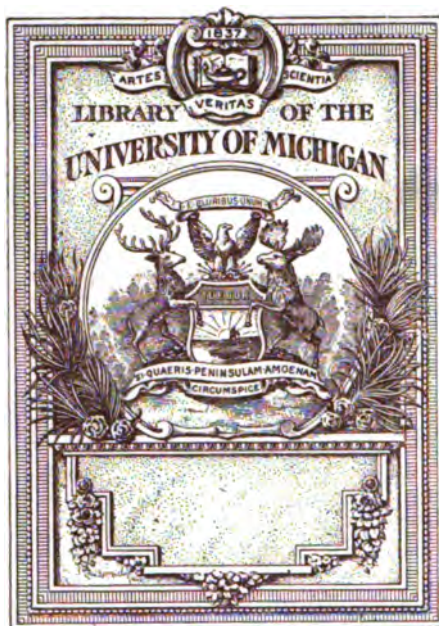
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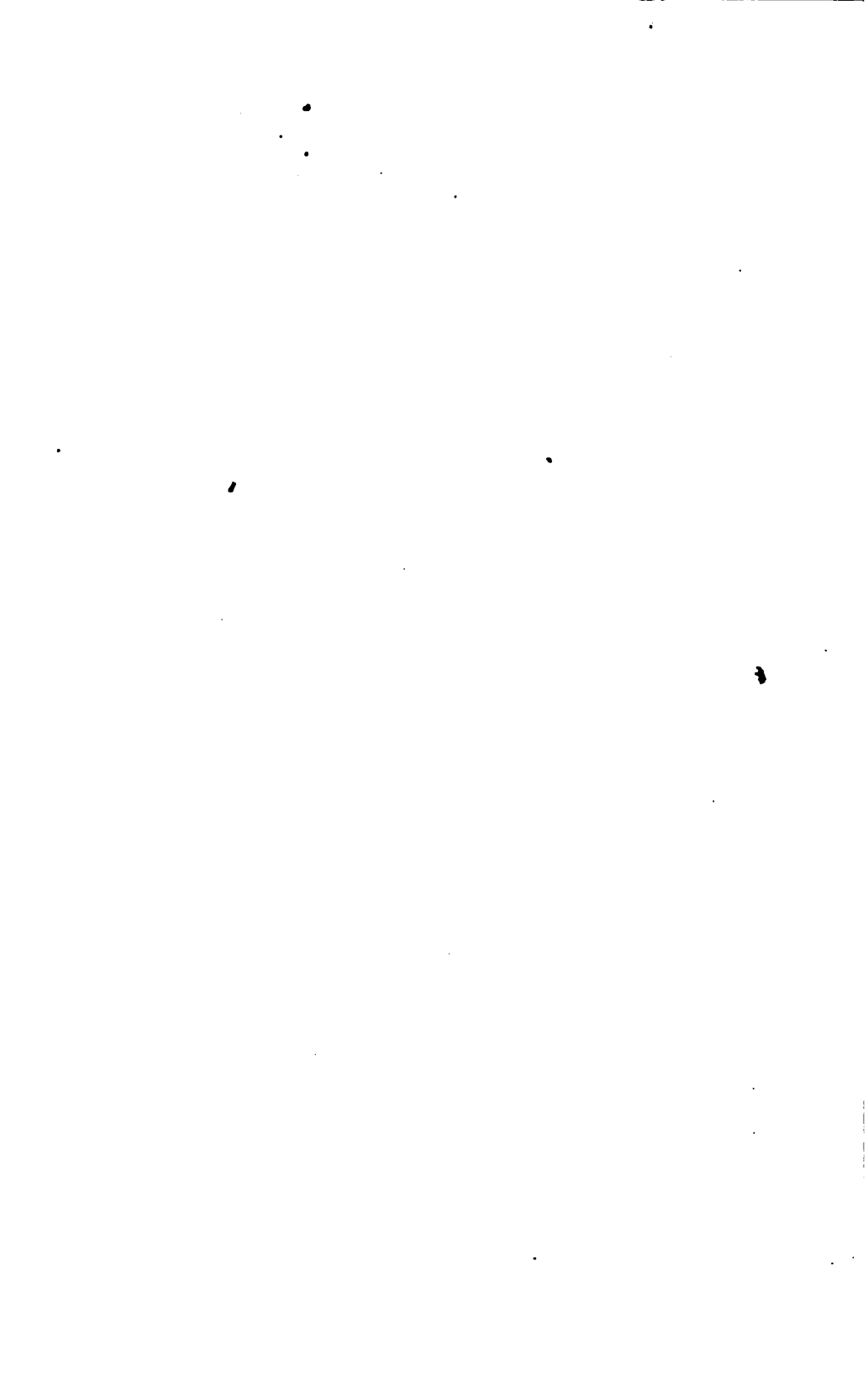
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PUBLIC DOCUMENTS
OF THE
STATE OF CONNECTICUT
VOL. IV PART 2

1905

Printed by Order of the General Assembly

HARTFORD
1906

NOTE.

Commencing with the documents for the year 1900, a Document Number has been assigned to each State departmental report.

This number is determined by the chronological order of the first printed independent issue of such report and will in future be retained by it, thus showing the relative chronological place it occupies in the printed reports of the State.

A list of these reports, with the date of first printed issue and the document number of each, appears on the following page.

Asahel W. Mitchell.

Comptroller.

AUGUST 1, 1906.

CHRONOLOGICAL ORDER OF FIRST PRINTED REPORTS OF DEPARTMENTS.

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1.	Comptroller, 1807
2.	School Fund, 1809
3.	Governor's Message, 1817
4.	State Prison, 1828
5.	Bank Commissioners, 1838
6.	Adjutant-General, 1838
7.	Quartermaster-General, 1839
8.	Board of Education (first issued by Commissioner of Common Schools), 1839
9.	Vital Statistics (first issued by Secretary of State), 1847
10.	Treasurer, 1852
11.	Connecticut School for Boys (Reform School), 1853
12.	Railroad Commissioners, 1854
13.	State Librarian, 1855
14.	County Commissioners, 1862
15.	Connecticut School for Imbeciles, 1862
16.	Manual and Roll, 1864
17.	Insurance Commissioner, 1866
18.	State Board of Agriculture, 1866
19.	Fish and Game Commissioners, 1867
20.	Connecticut Hospital for the Insane, 1867
21.	Connecticut Industrial School for Girls, 1870
22.	Indebtedness, rate of tax, etc., 1874
23.	Bureau of Labor Statistics, 1874
24.	Connecticut Agricultural Experiment Station, 1878
25.	State Board of Health, 1879
26.	Statement of Vote for State Officers, 1880
27.	Criminal Business of Courts, 1880
28.	State Board of Charities, 1882
29.	Connecticut (formerly Storrs) Agricultural College, 1882
30.	Shell-Fish Commissioners, 1882
31.	Estimate of State Expenditures, 1885
32.	Dairy Commissioner, 1887
33.	Factory Inspector, 1887
34.	Storrs Agricultural Experiment Station, 1889
35.	Board of Education of the Blind, 1895
36.	Highway Commissioner, 1897
37.	Building and Loan Commissioner, 1898
38.	Commissioner on Domestic Animals, 1898
40.	Attorney-General, 1900
41.	Commission of Public Records, 1900
42.	Dental Commission, 1901
43.	Israel Putnam Memorial Camp Ground Commissioners, 1902
44.	Connecticut Prison Association <i>de</i> Probation Law, 1903
45.	State Police Department, 1903
46.	Mediation and Arbitration, 1901
47.	Geological and Natural History Survey, 1903
48.	Tax Commissioner, 1903
49.	Soldiers' Hospital Board, 1905

LIBRARY NOTE.

In order that each department report of the State of Connecticut for a series of years may be quickly located in the bound volumes of Public Documents, the Comptroller has also given each report a Binding Number by which its position in the bound volumes is permanently established, thus enabling each report to be found in the same position and volume from year to year.

That these several reports may be placed in the libraries of our several exchanges as soon as convenient after publication, he has provided that the State Librarian shall be supplied with two hundred sets bound in volumes of convenient size, each volume to be bound and labeled in harmony with the regular set and sent out as soon as possible after the printing of the reports belonging therein. This arrangement began with the reports for 1902.

GEO. S. GODARD,
State Librarian.

Connecticut State Library,
August 1, 1906

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THEODORE SEDGWICK GOLD.

State of Connecticut
PUBLIC DOCUMENT No. 18

THIRTY-NINTH ANNUAL REPORT
OF THE
SECRETARY
OF THE
Connecticut Board of Agriculture

1905

PRINTED BY ORDER OF THE LEGISLATURE

Hartford Press
THE CASE, LOCKWOOD & BRAINARD COMPANY
1906

PUBLICATION
APPROVED BY
THE BOARD OF CONTROL.

TO HIS EXCELLENCY

HENRY ROBERTS,

Governor of Connecticut :

In accordance with the provisions of an act creating the State Board of Agriculture, I have the honor to submit herewith the Report for the year ending December 31, 1905.

JAMES F. BROWN, *Secretary.*

NORTH STONINGTON, December 31, 1905.

STATE BOARD OF AGRICULTURE.

1904-1905.

HIS EXCELLENCY HENRY ROBERTS, *ex officio*.

APPOINTED BY THE GOVERNOR AND SENATE.

	Term Expires.
CHARLES L. TUTTLE, . . . Hartford, . . .	1909
L. H. HEALEY, . . . North Woodstock, . . .	1909
CHARLES E. CHAPMAN, . . . Westbrook, . . .	1907
IVERSON C. FANTON, . . . Westport, . . .	1907

APPOINTED BY THE GENERAL ASSEMBLY.

Hartford County, .	EDMUND HALLADAY, Suffield, . . .	1909
New Haven County, .	D. WALTER PATTEN, North Haven, . . .	1909
New London County, .	JAMES B. PALMER, Jewett City, . . .	1909
Fairfield County, .	SEAMAN MEAD, Greenwich, . . .	1909
Windham County, .	N. G. WILLIAMS, Brooklyn, . . .	1907
Litchfield County, .	EDWIN G. SEELEY, Roxbury, . . .	1907
Middlesex County, .	W. L. DAVIS, Durham Center, . . .	1907
Tolland County, .	CHARLES A. THOMPSON, Melrose, . . .	1907

OFFICERS OF THE BOARD.

GOVERNOR HENRY ROBERTS, *President ex officio*.

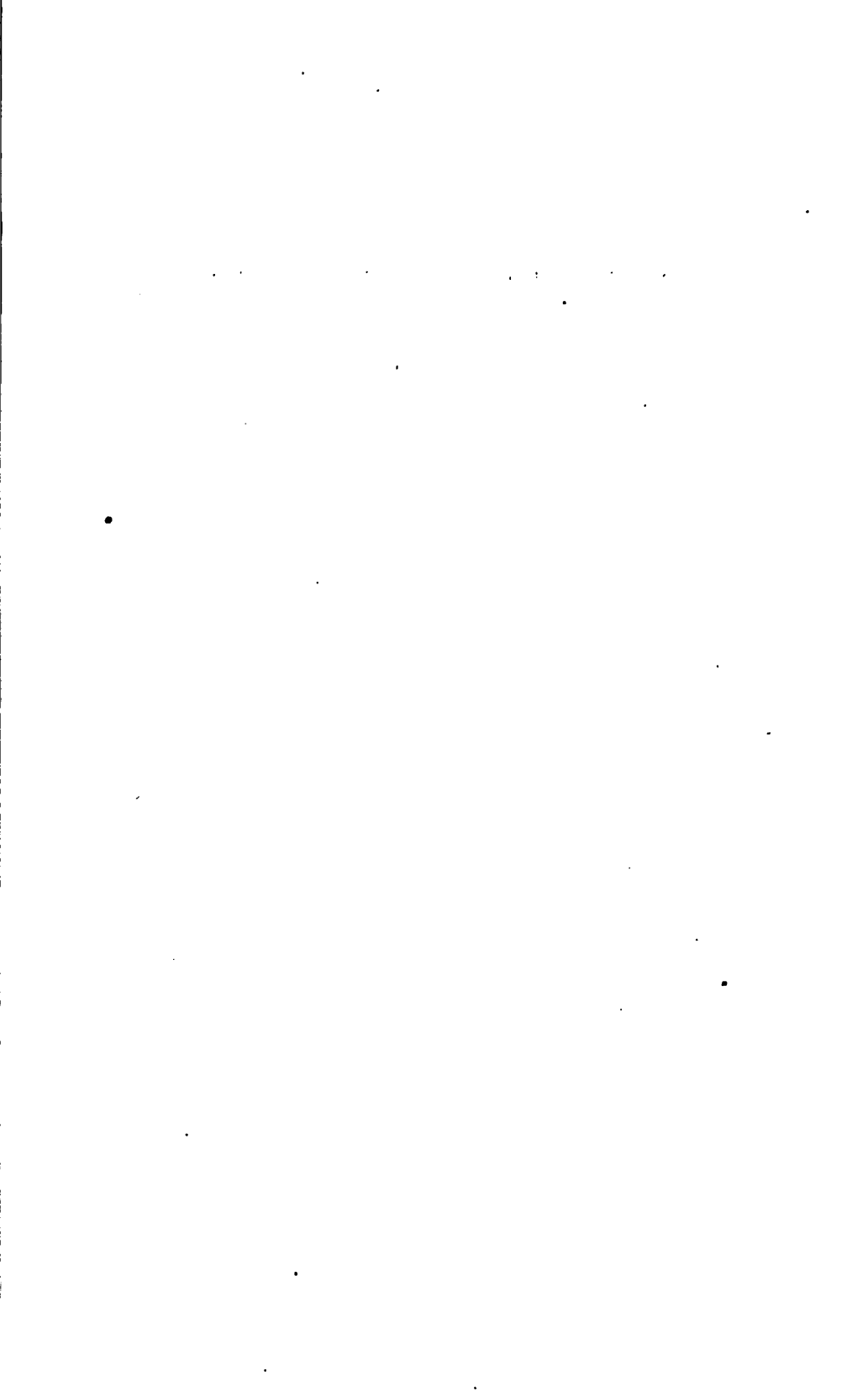
EDWIN G. SEELEY, . . .	Roxbury, . . .	<i>Vice-President.</i>
JAMES F. BROWN, . . .	North Stonington, . . .	<i>Secretary.</i>
CHAS. A. THOMPSON, . . .	Melrose, . . .	<i>Treasurer.</i>
DR. E. H. JENKINS, . . .	New Haven, . . .	<i>Chemist.</i>
DR. G. P. CLINTON, . . .	New Haven, . . .	<i>Botanist.</i>
DR. W. E. BRITTON, . . .	New Haven, . . .	<i>Entomologist.</i>
N. S. PLATT, . . .	New Haven, . . .	<i>Pomologist.</i>

Auditors.

SEAMAN MEAD

D. WALTER PATTEN

CHAS. E. CHAPMAN.



REPORT OF AGRICULTURAL FAIRS IN CONNECTICUT, 1905.

Delegate.	Name.	Place.	Date.	President.	Secretary.
L. H. Healey	New London County	Norwich	Sept. 12-14	E. J. Miner	T. W. Yerrington
C. E. Chapman	Windham County	Brooklyn	Sept. 12-14	F. H. Deming	I. B. Stetson
C. A. Thompson	Beacon Valley	Naugatuck	Sept. 4	Wm. J. Noble	Wm. L. Lloyd
I. C. Fanton	Berlin	Berlin	Sept. 20-22	C. M. Jarvis	W. W. Christian
W. L. Davis	Branford	Branford	Sept. 4-5-6	Edwin Doolittle	J. P. Callahan
C. E. Chapman	Chester	Chester	Oct. 4	Benj. E. Harwood	Edgar W. Lewis
L. H. Healey	Colchester Grange	Colchester	Sept. 19	J. R. Dutton	M. R. Abell
E. G. Seeley	Danbury	Danbury	Oct. 2-7	S. H. Rundie	G. M. Rundle
C. L. Tuttle	Farmington Valley	Collinsville	Sept. 6-7	O. F. Perry	E. A. Hough
E. Halladay	Granby	Granby	Sept. 27-28	Geo. O. Beach	Theodore G. Case
S. Mead	Greenfield Country Club	Greenfield Hill	Sept. 12-15	N. H. Sherwood	Mrs. D. B. Adams
W. L. Davis	Guilford	Guilford	Sept. 27	A. Minor Leece	Robert De F. Bristol
C. A. Thompson	Harwinton	Harwinton	Oct. 3	Wm. J. Barber	L. O. Catlin, Torrington
J. F. Brown	Mad River Grange	Waterbury	Nov. 7-9	A. J. Pierpont	Thomas Petit
D. W. Patten	New Haven Co. Hort. Soc.	New Haven	Sept. 12-15	R. D. Pryde	J. E. Hungerford
D. W. Patten	New Milford	New Milford	Sept. 26-28	J. Leroy Buck	P. H. McCarthy
E. G. Seeley	Newtown	Newtown	Sept. 4-5-6	R. C. Mitchell	A. D. Clark
I. C. Fanton	Orange	Orange	Sept. 2-4-5	W. S. Woodruff	E. M. Arnold
D. W. Patten	Putnam Park Association	Putnam	Sept. 26-28	M. R. Joy	A. L. Martin
S. Mead	Rockville Fair Association	Rockville	Oct.	A. Kingsbury	Geo. C. Eno
C. L. Tuttle	Simsbury	Simsbury	Oct. 3-4-5	E. A. Hoskins	C. F. Beckwith
N. G. Williams	Stafford Springs	Stafford Springs	Sept. 20	E. C. Dennis	A. F. Warner [ardville
S. Mead	Suffield	Suffield	Sept. 26-27-28	Waldo S. Knox	Henry F. Fletcher, Haz-
C. A. Thompson	Union (Somers, etc.)	Broad Brook	Sept. 19-21	C. A. Arnold	N. W. Heater, Pequabk
E. G. Seeley	Waterbury Driving Co.	Waterbury	Sept. 18-20	O. G. Camp	C. C. Harris
I. C. Fanton	Horseshoe Park Agr. Ass'n	Wethersfield	Jan. 17-18, '06	J. G. Adams	T. R. Sadd
J. B. Palmer	Woodstock	Willmantic	Sept. 26-28	Chas. A. Gates	L. H. Healey, N. W.
C. L. Tuttle	Conn. Dairymen's Ass'n	Hartford		Chester E. May	J. G. Schwink, Jr., Mer'n
N. G. Williams	Conn. Pomological Society	Rockville		H. O. Daniels	H. C. C. Miles, Milford



FARMERS' INSTITUTE IN 1905.

By vote of the board all its members were included in the committee to superintend the work of Farmers' Institutes, each member to provide for the special needs of his own section of the State.

Pursuant to this plan Institutes were held as far as possible wherever desired throughout the State.

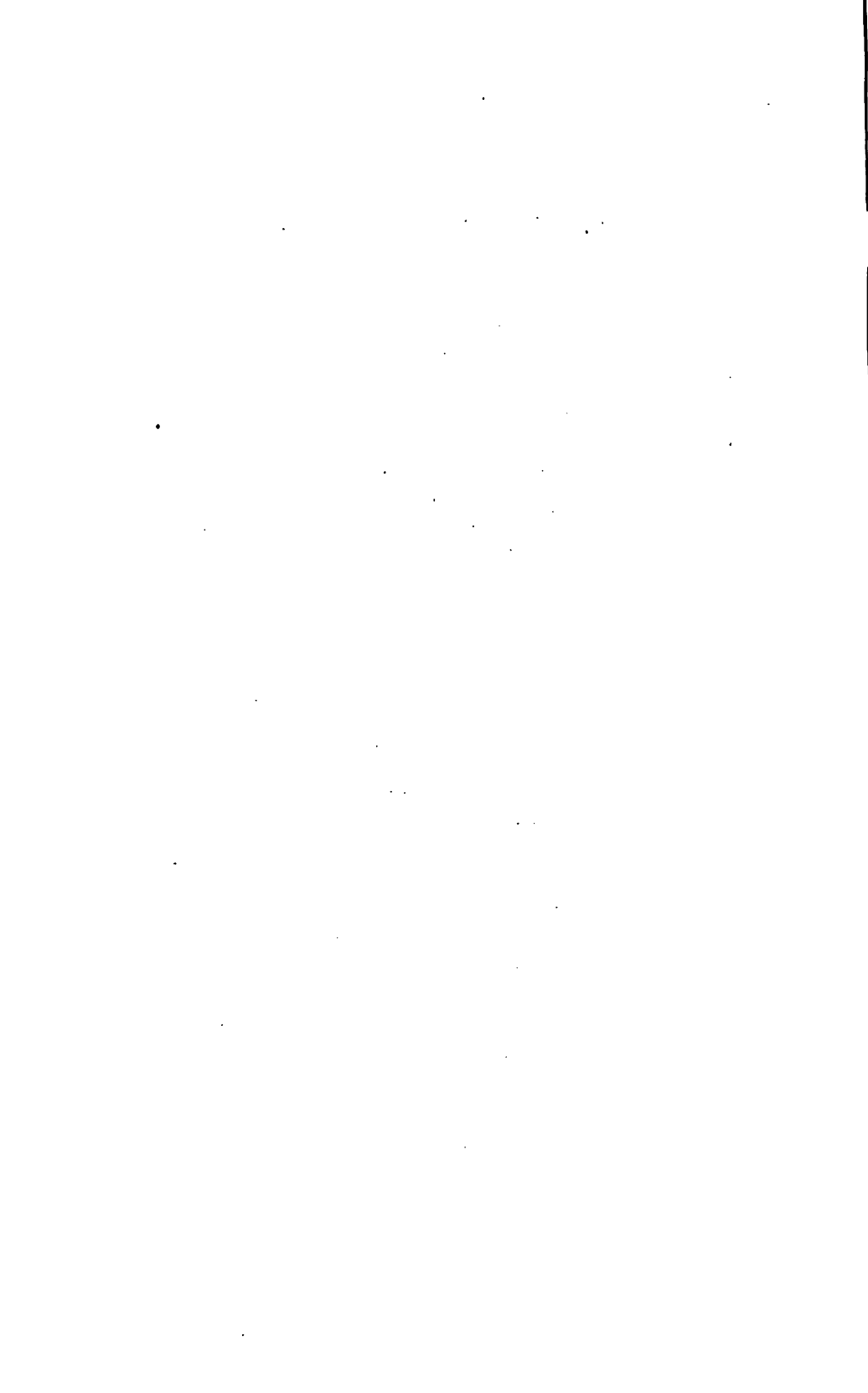
The tobacco growers were especially fortunate in having the services of Mr. A. D. Shamel, of the U. S. Dept. of Agr., an expert in plant breeding and seed selection, who addressed many meetings throughout the tobacco growing area, not only during the winter and early spring, but well along in the growing season.

He was ably assisted in this work by Dr. E. H. Jenkins, director of the Connecticut Agr. Exp. Station, who has given the fertilization of tobacco careful scientific study and is justly regarded an authority on this subject.

This part of our Institute work has been attended with the most satisfactory and beneficial results.

The board has also had the hearty co-operation and support of Mr. J. K. Graham, manager of the poultry department of the Connecticut Agricultural College, who has addressed many institutes for the promotion of this important industry, which is now receiving the attention it justly deserves.

There is no provision of law for a director of Farmers' Institutes in Connecticut as there is in many States, but in few, if any, are more Institutes held in proportion to its farming population. In addition to these held by this board many successful Institutes have been held along their respective lines by the Connecticut Dairymen's Association, the Pomological Society, the Bee Keepers', Sheep Breeders', and Tobacco Growers' association.



AGRICULTURAL CONVENTION AT WILLIMANTIC.

The annual midwinter meeting of the Board of Agriculture was held in Town Hall, Willimantic, Dec. 12, 13, and 14, 1905, in accordance with the following programme. Favorable weather, attractive speakers, and a large attendance made it one of the most enthusiastic and successful meetings of recent years.

The exhibits of fruit and other field and farm crops were less in evidence than in some previous years, but what was much more important the producers themselves were there and entered heartily into the spirit of the meeting.

Tuesday, December 12th.

10.30 A. M. MUSIC BY THE LOOMER OPERA HOUSE ORCHESTRA.

10.30 A. M. INVOCATION.

Rev. Ashley D. Leavitt.

10.45 A. M. ADDRESS OF WELCOME.

His Honor Daniel P. Dunn,
Mayor of Willimantic.

RESPONSE BY

His Excellency Henry Roberts,
Governor of Connecticut.

11.30 A. M. ADDRESS — "What the Department of Agriculture is doing for the Farmer."

By Dr. H. J. Weber,
Washington, D. C.

2.00 P. M. ADDRESS — "The Essentials of Success in Future Sheep Breeding."

By Dr. C. D. Smead,
Logan, N. Y.

DISCUSSION.

7.30 P. M. MUSIC.

8.00 P. M. ADDRESS — "The Story of Soils and Plants in their Relation to Liming." Illustrated with stereopticon.

By Prof. H. J. Wheeler,

Director R. I. Agr. Exp. Station.

Wednesday, December 13th.

9.30 A. M. MUSIC.

10.00 A. M. ADDRESS — "Poultry Management."

By Mr. Tillinghast,

Vernon, Conn.

10.30 A. M. ADDRESS — "Dry Feeding: The New Poultry Culture."

By Mr. A. F. Hunter,

Associate Editor American Poultry Advocate.

11.30 A. M. ADDRESS — "The Real Origin and Development of Poultry in Modern Times."

By T. F. McGrew,

Washington, D. C.

2.00 P. M. ADDRESS — "Breeding Animals on the Farm."

By Prof. Thos. Shaw,

St. Anthony's Park, St. Paul, Minn.

DISCUSSION.

7.30 P. M. MUSIC.

8.00 P. M. ADDRESS — "How Shall We Attract Useful Birds About our Farm Houses?" Illustrated with Stereopticon.

By Dr. Edward Howe Forbush,

Wareham, Mass.

Thursday, December 14th.

9.30 A. M. MUSIC.

10.00 A. M. ADDRESS — "The work of the Forest Service for Farmers."

By Herbert A. Smith,

Washington, D. C.

11.00 A. M. ADDRESS — "Alfalfa in Connecticut."

By E. H. Jenkins,

Director Conn. Agr. Exp. Station.

DISCUSSION.

2.00 P. M. ADDRESS — "Feeding Farm Animals."

By Prof. Thomas Shaw,

St. Anthony's Park, St. Paul, Minn.

DISCUSSION.

7.30 P. M. MUSIC.

8.00 P. M. ADDRESS — "Why Present Conditions Necessitate a Knowledge of Dietetic Value of Foods."

By Mrs. Sara Walrath Lyons,

New York City.

To get the largest good out of the meeting the audience must take part by question or discussion.

To give all an opportunity to present any subject affecting the interests of Agriculture, a Question Box will be provided, which it is expected will be freely used for the presentation of practical questions which will be taken up and discussed as opportunity offers.

To make this feature of the meeting profitable, bring in your questions and take part in the discussions.

Ample facilities will be afforded for the exhibition of Fruits and Flowers, Grain and Vegetables, Butter and Cheese; and the bountiful harvest just gathered warrants the hope that there will be a generous exhibit. Mr. N. S. Platt, Pomologist of the Board, will give his personal attention to this feature of the programme.

Articles for exhibition may be sent, properly labeled, by express, at the expense of the Board, to the Secretary at Willimantic, to arrive on Monday, December 11th.

RAILROAD ARRANGEMENTS.

The N. Y., N. H. & H. R. R. Co. has provided certificates which, when countersigned by the secretary, will entitle the holder to return over any of its lines at half rates. These certificates must be shown when purchasing tickets at railroad stations in Willimantic or New London.

HOTEL ACCOMMODATIONS.

The headquarters of the Board will be at the Hooker House.

A committee of the Board will be at the Hall to furnish delegates and others such information as may be required.

Gov. HENRY ROBERTS,
EDWIN G. SEELEY,
N. G. WILLIAMS,
L. H. HEALEY,
JAMES F. BROWN,

Committee.

NORTH STONINGTON, Nov. 25, 1905.

REPORT
OF THE
PROCEEDINGS OF THE CONNECTICUT STATE
BOARD OF AGRICULTURE

AT
WILLIMANTIC, CONN., DECEMBER 12, 13, AND 14, 1905.

MORNING SESSION.

WILLIMANTIC, CONN., December 12, 1905.

Preceding the opening of the Convention an enjoyable concert was given by the orchestra of the Loomer Opera House of Willimantic.

Convention called to order at 10.30 A.M., in the Town Hall, Willimantic, by Secretary James F. Brown.

Secretary BROWN. The hour having arrived for the opening of the Convention we will listen to an invocation by the Reverend Mr. Leavitt of Willimantic.

Rev. Mr. LEAVITT. Let us invoke God's blessing. Lord God, Eternal Spirit, Immortal and Holy Judge, Merciful Maker of all things' in being, and by Thy power the ruler of all things in Thy wisdom, we adore Thee for the wonders of Thy earth and of Thy heaven, and for Thy living spirit among us. We give Thee thanks for all Thy manifold blessings that Thou dost continually shower upon us; we bless Thee and thank Thee for the harvests of our fields, the plentiful ore in the earth, and spirit of richness and growing prosperity among us, and for all of those rich stores of inspiration and suggestion in our fellowship one with another.

We beseech Thee that Thou wilt continue to give us insight into the secrets of nature, skill to our hands, and increase in us capacity for wisdom and efficiency that we may be worthy of the prosperity Thou hast blessed us with, and worthy of all high undertakings. And especially would we beesech Thy blessing upon this assembly. May thoughts of Thee occupy our deliberations, and wilt Thou enable us to trace out Thy wonderful workings in all the laws and forces of nature that we may come more and more into harmony with Thee, and with Thy purposes in the world, and that through Thee we may provide for ourselves and for those dependent upon us a worthy subsistence. And wilt Thou keep us continually in peace and good fellowship. Enrich our hearts and our lives through Jesus Christ our Lord. Amen.

Secretary BROWN. I have the pleasure now of introducing to this audience the son of one of the gallant soldiers of my old regiment that went to the front with me forty-three years ago, and who now comes to the front as the chief executive of the City of Willimantic. I take pleasure in introducing his Honor, Mayor Dunn, of Willimantic.

Mayor DUNN. Mr. Secretary and gentlemen of the Connecticut Board of Agriculture, ladies and friends: When I met Colonel Brown on the outside and he told me that he was in the same regiment with my father, a thrill of pride ran through my heart when I thought of the heroes of '61, and heard that the secretary of your organization was in the same regiment with my father: I felt proud of it indeed. But, ladies and gentlemen, I am not here to discuss that subject, but here to welcome you to this grand old city of ours, the city of spindles, a city known all over this State as the "Thread City." I welcome you here today. As the representative of the people of this city, I assure you that I express the sentiment of the people who have a high respect and appreciation for the Connecticut farmer for what you

have done. The exhibits at the agricultural fairs held all over the State of Connecticut show today that the farmers are a progressive people, and not only progressive, but, like the mechanic and inventor, they have worked out ideas, studied them up and applied them, until today old line farming has almost passed away and business farming taken its place. Today the prosperity of the farmer is known, not only in the financial world but everywhere. He will soon stand at the head. It is only a question of a few short years when the farmers of this country will be the leaders in our country's wealth. Just look around, all over the State of Connecticut, in the farming districts, and what do you see? Not only in Connecticut, but all over this broad country of ours the farmer today shows prosperity everywhere. Beautiful homes, magnificent barns and stock-houses, well-fed stock on every hillside, beautiful poultry running everywhere, and the thrifty farmer with his many assistants at work in the fields is a sight worth witnessing indeed. But, my friends, I am not here to discuss the subject of farming and agriculture. The eminent men that appear on your programme will, I have no doubt, deal with that subject to the satisfaction and instruction of our people, not only the farmers, but their efforts will be a school of instruction for the citizens of Willimantic. I hope and trust that when this convention adjourns and you leave for your happy homes that you will leave feeling that the people of our city have received useful and instructive knowledge as well as yourselves on the subject of farming.

Now let me say to you again before closing that as the representative of the people of this city I welcome you, and not only welcome you, but in their behalf I extend to you the freedom of this city. It is yours. Do with it as you please. Visit our places of industry, visit our places of business, and when you leave our city, let us hope that the favorable impression that you have formed will be as lasting as the love and

respect that the citizens hold for the honest, upright, and thrifty farmer.

Secretary BROWN. The programme at this point calls for a response by His Excellency, Governor Roberts. I have to say that I have just received a letter from the Governor in which he regrets that business engagements detain him from our presence. I will read his letter.

HARTFORD, December 7, 1905.

Col. James F. Brown,
Secretary, North Stonington.

My Dear Sir: Replying to yours of December the fifth, I promised partially, if possible, to be present at Willimantic at the midwinter meeting of the Board, but I find at this writing that it will be impossible for me to be present.

I regret this very much, as I should have been very much interested in the proceedings of your meeting. The agricultural interests are of such value to the State that I feel that any official of the State should do all he could, either by his presence or his efforts to stimulate and foster them. I know they are well taken care of by our efficient Board of Agriculture, but it would be interesting to note the progress these interests are making and to do everything in one's power to assist.

Regretting that I cannot be with you at this meeting, but hoping at some future time to have that pleasure and profit, I beg to remain,

Sincerely yours,

HENRY ROBERTS.

Therefore, owing to the unavoidable absence of our Governor, I have the pleasure to introduce to you our Vice-President, Mr. Seeley, who will preside at this session, and respond, in the Governor's place, to this warm address of welcome, which we have just had from the Mayor of Willimantic.

Vice-President E. G. SEELEY. Your Honor, the Mayor of Willimantic, and ladies and gentlemen: I was informed after coming into this room that the Governor was not to be here. That was the first intimation I had of it, and that, consequently, this response devolved upon the Vice-President. Well, I said, give me a chance to get out into the open air, and I walked down the street a little way thinking what I would say and what I would do, and do you know what came into my mind as I passed down the street? I remembered about that grand old patriot, Cincinnatus, who was called from the plow to arms. I remembered, when reading and studying about him in history when a boy, my father said to me, if ever you are placed where you cannot help it, and a responsibility rests upon you, do the best you can. Do not make unnecessary excuses or back out under those circumstances. So, following that instruction which has remained with me all these years, I will endeavor to say a few words in response to the very hearty welcome extended to us by the Mayor. Perhaps it is only proper, to commence with, that I should say that we come here not as a band of robbers; not as a band of impostors, for we do not come here in any such guise. We practice no jugglery and none of the fine arts. We are a kind of insurance company, but it is not exactly the kind of insurance that some companies have been carrying on, because we pay our premiums and we take none ourselves. We have not even a place to lay our heads if we depended upon the State Board of Agriculture, because we get nothing. We have no graft in any shape. We are simply men of the soil and men of toil. We have come among you and we are glad to have this hearty welcome and see so many faces here at the opening of our meetings. We are very glad to come among you and feel something of the warmth and kindly greeting extended by your Mayor.

Let me say to you what perhaps many of you have noticed, that the year book of the agricultural department, as issued

by Secretary Wilson lately, shows that the agricultural products of this country today exceed more than six billion dollars. That is the size of the farming industry in the United States. Think of it! What an immense sum that is! Why, you cannot compute it. It is more than all the mines. More than all the financial power. It is really greater than the railroads or any of the other vast interests of the country. Where does it come from? Well, it comes from the soil. How does it come from the soil? Why, the most of it comes through the labor and the brains of the people who live upon the soil. You cannot get away from that. It comes from those who plod right down to the earth. Can there be any doubt then about the agricultural interests of this country? Mark what I say. It must be upon the agricultural interests of this country that is based the perpetuity and maintenance of this nation of ours. It cannot be otherwise. Look among any other class of people on this broad earth, and you cannot find such a condition as that anywhere else. It comes from the agricultural interests of this country, the basis of which is Mother Earth. That is all there is to it.

Now as to our mission. We come only as plain common people among you. We are glad to be welcomed as we have been. We come to receive good at these meetings, and we hope we shall be able to do you good. We certainly shall receive benefit if we get your cordial sympathy and your coöperation in the little work that we intend to do.

Thanking you, Mr. Mayor, for this hearty welcome which you have extended for the people of Willimantic, I again say we are glad to be among you this morning, and to receive this greeting. (Applause.)

Now the next thing on our programme seems to be an address on "What the Department of Agriculture is Doing for the Farmer," by Dr. H. J. Webber, of Washington, D. C. I have the honor of introducing the gentleman to you now.

"WHAT THE DEPARTMENT OF AGRICULTURE IS DOING FOR THE FARMER."

BY DR. H. J. WEBBER, Washington, D. C.

Mr. Chairman, ladies and gentlemen: I feel some hesitation in attempting to explain the work of the Department of Agriculture. Although I have been connected with this institution for the last fourteen years, and have followed its growth from a comparatively small institution to its development to the enormous position it occupies today, still it is practically impossible for any one man concerned with particular investigations, as I am, to explain many of the details and various workings of that Department. You gentlemen who are engaged in agricultural matters understand that it is necessary for us to specialize in order to make advancement. My specialty has been along the line of plant breeding. Therefore, you will understand that I only comprehend in an indefinite way the other lines of work which are prosecuted. Still, I will attempt to explain some of the general features, and if I fail in this, kindly overlook it and take up some of the books and bulletins of the Department that will explain in detail, and very much better than I can do, any particular points about which you may wish for information.

This department has grown as marvelously as the growth of the farming industry has been marvelous. In July, 1897, the Department of Agriculture employed 2,160 men, while just a few years later, in 1904, the Department employed 4,504 scientific investigators and helpers. Besides these we have over a quarter million of special correspondents and co-operators, who are looking up all lines of work. Many of you gentlemen are probably taking part in that. The growth of this Department, however, is simply a reflection of the growth of the country as a whole, and the growth of the agricultural interests. Our chairman spoke of the enormous figures represented by this industry, taking his figures, I suppose, from those contained in the Secretary's report. Now let me give you those a little more in detail simply to impress this matter upon your mind. Conceive, if you can, the value of the corn industry. Corn, that little thing that we see every day. We grew last year 2,208,000,000 of bushels of corn, at

a valuation of \$1,216,000,000, an amount probably exceeding any other industry in the United States, unless it be the steel industry. Last year our hay crop was valued at \$605,000,000; cotton, \$525,000,000. The cotton on which the products of the industries of this city depend aggregated that enormous total. Oats, \$283,000,000; potatoes, \$138,000,000; barley, \$68,000,000; tobacco, which you are all interested in, in Connecticut, \$52,000,000; horses, \$1,200,000,000; cattle, \$1,144,000,000; hogs and sheep, \$249,000,000. These items, together with the valuation of other minor farm products, gives us the enormous total of \$6,411,000,000, representing the product of our farms in the United States during the last year,—something entirely beyond imagination, a sum stupendous in its magnitude and far greater than the product of any other industry of the country. But what are the other results of this? Naturally with this increase in the valuation of farm products comes an increase in the valuation of the farms themselves. Farms which yesterday, or which a few years ago, could be purchased for from \$25.00 to \$50.00 an acre are held at \$100.00 and \$125.00 an acre now. Almost all over this country lands, and old lands, have increased in value, and new lands have been brought into the market and brought under cultivation. The increase in values during the last five years is estimated to be \$1,133,000,000, or, as the Secretary has put it, every sunset has registered an increase of \$3,400,000 in the farm values of this country, and every month has registered an increase of \$102,000,000. I tell you, gentlemen, the wealth of this country is in the hands of the farmers. No matter what others may say, the wealth is in the hands of the farmers, and it is distributed individually here and there exactly as wealth should be distributed. Now it would seem probable to us with all this great increase in values in farm products and in the value of our farms that we have reached the maximum development, but, Mr. President and gentlemen, I want to tell you that this increase has just begun. We cannot lie still and think we have reached the maximum. This increase has been brought about simply by intelligent effort, by the intelligence behind the plow. And that reminds me of a little story I read the other day in reference to an Irishman. The Irishman was in the back coach of a railway train, and a gentleman came along

to him, and he says, "Pat, what are you sitting back here in this coach for? Don't you know that the last car is the easiest to jump the track, and that accidents are more apt to happen in the rear coach?" "Well," says Pat, "why don't they take off the rear coach then?" Now that is the way with us. Of course, they couldn't take it off, and we cannot stop our development. Furthermore, we cannot afford to if we can, for, as a matter of fact, we have competitors all over this broad earth of ours. Our wheat growing industry must compete with South America. Our cotton growers must compete with the cotton grown in Egypt, in Porto Rico, in the West Indies, and in other countries all over this broad globe. If we are to keep in the van of this great commercial advancement we must hold our present position. We must have investigators. We must advance all along the line. I think that is what you are doing, and it certainly is a most satisfactory situation.

Now the Department of Agriculture has a part to play in this great development. We use four thousand men investigating the subject, and with such a number as that at work there is bound to be something doing. I think I could give you possibly a more interesting talk if I was to talk on tobacco or on some particular subject with which I am familiar, but I am here to talk about the Department.

Now we have in the first place our organization. The great Department of Agriculture is divided into bureaus which represent certain subjects relating directly or indirectly to agriculture which they are investigating. Take our weather bureau. Who has not heard of the weather bureau of the Department of Agriculture? We are expending \$1,500,000 on this bureau annually. Still we hear some say, what has it accomplished. I have heard it said, ladies and gentlemen, that the most important work of the Department was to furnish us with something to talk about. Well, all of us like to talk about the weather at times. That may be true, for the weather is of special interest to us all. But I want to tell you that the bulletins of the weather bureau are in every city, and almost every town of this country. With the daily maps the report goes to every village and hamlet in this broad land of ours, and you know and I know that every mariner before he sails looks at the weather report to see whether there is going to

be a storm, and if the weather report says a storm is coming on, or a hurricane, you know very well he enters a safe harbor and waits for the storm to pass. So with the vegetable grower. If he hears the warning of a coming frost you know that he goes out and covers up his plants. You know that the orange grower also if he sees the cold wave flags flying, goes out to his orchard and banks up the trees and prepares his rosin to burn, and all things of that kind, in order to protect his trees against injury. So with other industries. That is the way the thing goes. I think we can safely say that thirty millions of our people know of the weather bureau of the Department of Agriculture and its work, and no matter how we may be inclined to laugh at these reports and joke about them, nevertheless down in our hearts we respect them, and the fellow who has property values dependent upon the weather is pretty sure to use them as a true criterion of what the weather is to be. The man who has property values depending upon the weather follows those reports almost certainly and surely. That shows what their real value is regarded as being in any line of work.

The next great work of the Department is the bureau of animal industry. Next to our plants animals are the greatest source of our wealth. What is the bureau of animal industry doing? That comes a little more closely to us because we are studying animals and plants more particularly, and yet I venture to say that few of us realize what the bureau of animal industry is doing for us, for so much of their work is done in an indirect way. In the first place, it has an enormous inspection bureau. You will remember that a large share of our wealth comes from foreign commerce, and that this foreign commerce is largely governed and controlled by the condition of the animals that we put upon the market, and if it were not for the inspection which the United States Government carries on through this bureau it would be practically impossible for us to ship cattle with the ease with which we ship them today. This bureau is not only charged with carrying on this enormous inspection work, studying how to do it with the most effectiveness, but they are also studying the diseases of animals with which we have to contend. If there is anything that creates consternation in the farmer's mind it is to have his stock taken sick with a disease which he is powerless to combat. Let us consider a few of the diseases which the Department is study-

ing. Take, for instance, blackleg, which affects our cattle industry so severely. Through a careful investigation by the men connected with this bureau, aided, of course, by the experiment stations all over the country, it has been found that we could put out a vaccine somewhat similar to the vaccine used to combat smallpox or diphtheria, by which we could immunize cattle, and greatly reduce the effect of the disease. Now the Department of Agriculture does that very thing. Instead of paying, as you have to pay, for antitoxin, an enormous sum, and which is almost prohibitive, the Department is sending out doses of this vaccine with instructions for administering it. During the last five years the Department has sent out on the average 1,750,000 doses of this vaccine, or whatever we may call it, per annum, for the treatment of blackleg alone. As the result of this enormous distribution of this material, and of other instructions that go with it, a loss which was at one time from ten to twelve per cent. of the entire amount of cattle grown has been reduced to one-twelfth of one per cent. Now I maintain that that is coming right down to the hard basis of fact and large usefulness. In the same way the hog cholera has been combated. A vaccine has been prepared and distributed which is greatly modifying the extent of the disease. Take it in the case of Texas fever about which a great deal has been said, and as the result of the study which has been given to it we are now able to control the spread of the disease. Take the sheep scab, with which the majority of you are familiar. They have been studying methods of treatment and control, and by the preparation of a dip prepared from tobacco, sulphur, and lime, with which you gentlemen are familiar, I think beneficent results have been attained. These are the several things we have got to do if we are going to control the diseases of our animals and the diseases of plants. Now what is the result of these requirements which are so much criticised? In 1899 there were 672,944 treatments. After that, as the result of the effectiveness of the treatment the number swelled rapidly until in 1905 more than seventeen million treatments were made. Now we have returns from nearly six million of these treatments, and the effective cases are figured up as 93.5 per cent., nearly a perfectly effective treatment. We can control many of these diseases if we simply stand together and exercise the best judgment and best knowledge which is obtainable..

Now one of the main lines of the work of this bureau is its inspection work and quarantine work. Many of you are doubtless familiar with the attack of foot and mouth disease which occurred here in 1902. You remember it started in Massachusetts and spread over into Rhode Island, Vermont, and New Hampshire. I do not believe it came into Connecticut. It did not, if I am correctly informed. If the disease had not been stayed it would, of course, have prevented the exportation of our meat. Commerce on that line would have been actually stopped if we had not found some way to control it. Now state boards of agriculture and the state authorities worked together with the Department of Agriculture in quarantining and bringing about an entire control of that disease, and as the result of the quarantine and of that work, over four thousand animals were slaughtered and disinfected. Congress made a special appropriation of \$500,000, I believe it was, to aid in the eradication of the disease. The Department paid very nearly \$130,000 for animals which were condemned and destroyed. So effective was that work that the year after the introduction of the disease, the year after it became broadcast over those three states, it was nearly stamped out, the quarantine was raised, and our exportation of meat went on the same as ever. Now those are things we hardly think of as being the work of the Department, but when you come to consider some of the efforts of the Department I want you to take all these matters into consideration. We have maintained a quarantine all along the coast and all along the borders of the United States to prevent the importation of infectious diseases. Sometimes we must do it. Some years ago there was a ship inspection law passed, providing for the inspection of ships, and for the treatment of those in an unsanitary condition certain regulations were prescribed. Now how does that affect the farmer? Just in this way. It made the ships more cleanly and safe, and as the result of that all the insurance rates fell over one hundred per cent. So it goes all along the line.

Now let me call attention for a few minutes again to this inspection work which is being carried on. We have here and there in connection with the great packing establishments of the country, men who are examining all these meats for exportation, examining the carcasses to see if they are diseased or in proper condition for food. Last year experts in the serv-

ice of the Department examined over forty million carcasses. Just think of it! Forty million carcasses were inspected and passed on, a great many of them in the meanwhile being condemned, simply to protect our homes against the utilization of infected meat which would be dangerous to life. Last year over 66,846 cars were inspected, and shippers required to put them in proper shape for the shipment of animals. Last year we inspected 731 ships to see that they were in proper condition for animals, and to see that the animals were held in the proper way. The Department also prescribes regulations regarding the shipment of cattle in order that they may be handled with all possible care and kindness. If they are not certain loss is sure to result. The Department insists, and the enforcement of these regulations makes it necessary for shippers to give a much greater degree of kindness and attention to these matters than was formerly the case.

In the dairy work of this great bureau there are being some exceedingly interesting things brought to light. For instance, in butter, of which we produce enormous quantities, an effort is being made to find a foreign market. We produce more butter than we want to use at home, and the question is, can we ship it abroad? Can we establish a market there? One of the great lines of work of the Department is to look into the possibilities of foreign markets for the purpose of seeing if we can establish trade in other places than those in which it now exists. In the first place, the question to be solved is whether we can ship butter. We have got to have refrigerators. In connection with that, experiments have been in progress at the New York and Wisconsin experiment stations where the Department has been studying the keeping qualities of butter, taking, for instance, a fifty-pound tub and subjecting it to different temperatures to see how it keeps. They have found some interesting facts. If I was to give the maximum, it would be something like five degrees below zero, while it has also been found that if we keep it at the ordinary temperature of, say, about twenty degrees above zero, the butter deteriorates. That is simply another line in which the Department is reaching out and striving to help the farmer by increasing the quality and increasing the market for farm products.

Take cheese. We are conducting experiments in connection with your station at Storrs, and also in connection with

the New York and Wisconsin stations relative to the preservation of cheese and the making of cheese. Everything indicates that some very beneficial knowledge will be obtained in these lines. We are carefully investigating that subject. Probably you gentlemen, many of you, are familiar with the results obtained at Storrs up to the present time.

With regard to foreign shipments of butter I neglected to state that on experimental shipments which have been made to Manchester, England, and various other places, they seem to indicate without question that we can establish a paying market in those localities, and every market of that kind that we can open up, is, of course, of the greatest benefit to every farmer. So much then for this great bureau of animal industry.

Now the next most important, and probably the greatest producer of wealth is the plant, and we have in connection with the Department the great bureau of plant industry, which is taking up the subject of plants from all sides and studying it in all its phases. One of the most important lines of work of this bureau is the treatment of plant diseases. Now if a man is at a loss when his stock becomes sick, why I must say that the ordinary man, ordinary individual, be he farmer or other, is more than at a loss when his plants become sick. We are not familiar with plants. We are with animals more or less, and know how to treat many animal complaints, but when our plants become sick then we are absolutely helpless. The pathological practice and treatment of plant diseases practically originated with this Department of Agriculture. I could not begin to tell you all the various diseases which have been studied carefully, and for which treatments have been proposed that are effective. Take, for instance, the peach leaf curl, with which many of you are familiar. This disease at one time caused widespread damage. There seemed to be no way to stop it. We now know, however, that by proper spraying we can control that disease. It is not merely in the discovery of remedies to combat such diseases that beneficial results have been obtained, that is not all. One of the main things comes in carefully studying the life history of the fungus which causes the disease, and finding out when this treatment must be applied to make it effective, and that is what is being done in every case. Take it in the case, for example, of the bitter rot of apples, which is a new

disease, and quite widespread over the western part of the country. It is estimated that that disease alone causes damage of over \$10,000,000 annually. The experts of the bureau discovered that by proper spraying at the proper time we are able to practically control that trouble. In our experiments this last season we saved over ninety per cent. of the crops where application was made of the spray, while in orchards adjoining those to which the applications were made the property was entirely ruined. Up-to-date farmers must watch these new methods and take prompt advantage of them. Take, for instance, the peach yellows, a disease which has been more or less prevalent in Connecticut and caused large losses. After carefully studying, it was found eradication of the diseased trees seemed to be the only proper remedy, the same remedy that we applied in the case of the foot and mouth disease. That was found to be the best method of treatment, and by that method we are able to control this disease, if farmers and all concerned will work together with us to do the work thoroughly.

We do not limit ourselves simply to the study of spraying methods and things of that kind, but we go into the production of new strains of plants to resist these diseases. Now I am going into a subject with which I am familiar because that is my line of work. It is more or less surprising to some people that a scientist should be able to produce an immune strain of plants. You know perfectly well that certain men are resistant to certain diseases. We know, for example, that one man may be exposed to yellow fever and not take it where another will take it. Another may be exposed to smallpox and resist the disease where perhaps another exposed at the same time will take it. We apply that same principle to the production of immune strains of plants. Wherever we can discover that tendency to resist we can usually by breeding produce an immune strain. This city depends largely on the cotton industry of the South, and we have been able to do something in this line, the benefit of which has been seen here. About ten years ago there appeared in the South a new disease that attacked the little fine roots of the cotton plants and ran up the main stem, soon causing the plant to wilt and die. We found that that fungus would maintain life for eight or ten years, and as the result of the presence of that disease some of the best cotton

lands in the South were abandoned ; it looked exceedingly serious. Take, for instance, James Island, where the finest cotton was produced, and lands worth from \$100 to \$125 an acre were plowed up and put into other crops, vegetables and other products, because they could not produce cotton. The disease spread into Alabama, Georgia, Florida, and into other sections of the South, and we thought it was going over the whole country and was liable to destroy the cotton industry. Now one of the men in the employ of the Department discovered that an occasional cotton plant here and there in the field seemed to resist the disease, and would produce a good crop of cotton when its neighbors were wilting and dying. Some experiments were tried. A few of these plants that seemed to be resistant were selected, the seed from those immune plants were planted, and as the result today we have produced some varieties of cotton which will resist that disease completely. When this resistant variety of cotton is planted in the center of a field of the ordinary kind it will stand up like a hedgerow while every plant on each side will go down as the result of the disease.

We had a similar experience in the case of a disease which attacked the cow pea, which is the clover of the South. We selected the seed from the resistant or apparently immune plants, went through the same process, and succeeded in producing an immune pea that would resist the disease.

As the result of these things today, gentlemen, those cotton fields which were abandoned are growing with fine staple cotton, and fields which would not produce a crop of cow peas in the South are growing with fine crops of this clover of the South. The tobacco growers of Florida, who have no cover crop because of the work, are now growing these cow peas resistant to the disease, and the pathologists of the Department, wherever we can, are discovering these troubles and propagating immune strains as rapidly as possible, putting them into the hands of the growers, and in that way have been able to do much.

Now the same sort of work has been carried on, more or less, in relation to tobacco, and several other crops. We hardly know what can be accomplished in this direction as yet, but from the beneficial results which have been produced in the case of cotton and other plants we feel confident that

breeders can go ahead and produce crops which are resistant to these diseases.

Now the breeding work of the bureau of plant industry extends to other lines. I want to speak about cotton, as long as that is one of the main products of your manufacturing in New England. All over this great country of ours, from South Carolina to Texas, we grow a little short staple cotton about three-quarters of an inch to an inch in length, and that is the staple which mainly reaches your mills in New England. In a few instances in the Mississippi valley, and in other sections of the South, they grow a staple cotton which is an inch and a half long. In the case of the former it is worth from six to eight cents per pound while in the case of the latter it is worth a much greater price. On some of the islands along the eastern coast of the South they grow the best staple cotton which is known in the country; in fact, the famous Sea Island cotton comes from that section. I like to impress this fact, that while we grow some of the short and poor staple cotton yet nevertheless we also grow the best, for that Sea Island cotton grows from two to two and one-half inches in length, and instead of selling from eight to ten and twelve cents a pound that sells right along for forty and fifty cents a pound for the best grade, and for the poorer grade from twenty-five to thirty cents a pound. Here was a chance to produce a better product by getting a variety, for instance, which would produce a longer staple. Every one familiar with the subject recognizes that if we had a longer staple we would have a better grade of goods because the longer the staple the stronger the thread and the better the wearing quality of the goods. Now the Department has taken up this question of the improvement of cotton. The Department experts said, why can we not produce a better staple cotton? We have here the best, and also, if not the poorest, some of the poor. We have on the one hand a short staple adapted to the climate all over the South, and on the other hand we find some varieties with fibres of the longest kind, and if these two could be combined, not with the idea of producing all of the best, but of substantially improving the poor, it would make an excellent cotton. So the suggestion was made that possibly by hybridizing these varieties and breeding them carefully we could produce a variety of cotton which might not be as good as the best, but

which would be substantially better than that which is more commonly grown. The experts of the Department took this up, crossed these two varieties of cotton and began to work towards the idea of producing a better species. That work has been nearly completed. It has reached a conclusion in certain lines this year, and we are sending out to the growers in the South a staple which instead of being less than an inch runs up from an inch to an inch and a half, but much longer than the ordinary grade, and which, of course, is worth more in the market because it will produce a better grade of goods.

Now in the same way we undertook the improvement of the tobacco crop. Many of you gentlemen are interested in that line of work. In the case of tobacco we believe we have already done something for the industry, and that we can do a good deal more. Our experts in studying this matter found, in the first place, that a point of great value to the grower was to separate his seed so as to use only the heavy seed. Well, you say, those of you who are familiar with the subject, how can that be done? The seed is so small that we can hardly see it any way. Well, that was the difficulty, but we found that by separating this seed and using only the heavy seed, we got a better yield, a better plant, and a more uniform plant. Of course, as I say, the difficulty was to separate the seed. One of our experts went to work and perfected a machine for separating the seed, patented the machine in the name of the government, so that any one of you could use it or make it without danger. Now if there is a tobacco grower here I think he has heard of that machine and of the results which came from the separation of the seed. That discovery in itself has been doing a good deal of good for the tobacco growers here in Connecticut, in Kentucky, and in Ohio.

Another thing. One of the greatest losses to the tobacco grower is from the fact that the crop is not uniform. When the shade industry was taken up in Connecticut a few years ago, and the effort made to grow Sumatra tobacco in the shade, it is probable as to that industry, if it can be said to have failed, it failed because of the variability of the product grown more than for any other reason. When we bring seed from any foreign country and plant it here for the first time we usually find that the plants produced are variable. We can correct that by breeding. If you want a certain type of Suma-

tra we can produce it. If you want a certain type of Sumatra with round leaves, or so that you can cut a certain number of cigar wrappers from them, we can produce it. If you want a round leaf we can get it. Think for a moment what it means to the growers if we can do that, two more leaves to each plant! That, of course, largely increases the crop and, of course, its value to the grower. That is just exactly what I believe careful breeding will do. We have been breeding animals for years. We understand that principle as applied to animals. Many of you are familiar with the gradual increase of the trotting record. You know that a few years ago it was thought that if a horse trotted in 2.16 it would be something marvelous, but we can, most of us, recollect the name of several horses that have trotted in better time. It was thought by some that the maximum had been reached, but breeders will tell you that that time has not only been considerably lowered, but that the record will be reduced slightly as the result of still further careful selection and careful breeding. Draft horses of different types are all the result of this question of breeding. Now, while we have understood this principle as applied to animals more or less, we have been letting our plants go. We have been considering that the plant came under a different category, so to speak, but we are coming to realize that we can breed them just the same as animals. The corn growers of the west are organizing to produce more and better corn. They say they can increase the yield ten bushels per acre, and some growers have done it. Cotton growers know from experience now that they can produce a largely increased yield, and a better crop in all respects as the result of seed selection. In the case of tobacco can we not by that same course of selection produce a larger yield? Every one of you men who have seen a tobacco field know that you have seen certain plants that will have from two to three and four or five more leaves than any other plant surrounding it. That is the plant for you to select your seed from. Up to about two years ago the policy followed in selecting tobacco plants for seed was simply to take a good part of the field near the barn, or near the house, as the case might be, where the plants were nice and thrifty, and leave a couple of dozen plants for seed. Now that does not accomplish the purpose. That is simply taking any plant growing

under good manurial conditions and thrifty because it is well manured. As the result of the Department's work, coupled with the work of the experiment station at New Haven — and your experiment station has been coöperating by furnishing funds and furnishing intelligence to run the work with — as the result of this work it has been settled that the way for the Connecticut tobacco grower today, as well as the growers of all other states, is to select a plant here and there throughout the field that is giving the best yield and the best growth, and to take the seed from those plants. By so doing he will be able to get a better yield and a better product. Our experts, however, have gone a little further. They found out that there was danger, owing to the fact that the seed of these selected plants were cross-fertilized, and they found out that if the seed from such plants became cross-fertilized it made plants raised from such seed variable. As the result of that, we have advocated that when such plants had been selected for seed that a bag should be placed over the blossoms to prevent cross-fertilization. This can be done by using a cheap manila paper bag which can be obtained at most any grocery store. By drawing that down over the seed head it prevents the admission of insects so that there will be no cross-fertilization. That policy has been pursued, has been put into operation by the tobacco growers, and I am glad to say with good results. I drove up and down the Connecticut Valley this last summer for a considerable distance, and could see the bags here and there all along the road. Sometimes I came across men who seemed to be a little bit doubtful. They did not know whether that would work out or not, and so they placed the bags upon seed heads that were hidden away from the road, but you could look over behind the hills and see the patches of tobacco occasionally with the bags upon them. I think that practically every man that has adopted this method and pursued it intelligently this year will testify to the good results that have been obtained. Why? Why gentlemen, this is not a theoretical matter. It is a practical fact. These are things that you can see just as plainly as I can see. They are results which can be accomplished by following advanced methods.

Some other very interesting things have been developed in the course of our work with the tobacco plant. For in-

stance, I told the growers of tobacco in Kentucky that it might be possible for us to produce suckerless plants. They laughed, but they all said if you can give us any of the seed we want some of it. Now it would seem impossible to produce a suckerless type of tobacco, but we hope to attain it. You know that one variety of apple branches out in a different way from another. If you are a cotton grower, you know that one brand is entirely different from another. We have one kind of cotton which branches out with great branches over the ground, and we have another type of cotton which is almost limbless. It will grow right up in a column like a cedar tree and produce bolls on each side. These things in nature are not uncommon. It is not such a marvel to produce a plant which is substantially changed from its normal form by the proper treatment, and that is exactly what we believe can be done with respect to the tobacco plant. If any of the growers have seen the experiments which the Department has been carrying on at East Hartford this last season you will bear me out in saying that we have several types there this year which are practically suckerless. I believe, gentlemen, that it is possible for the plant breeder, working with intelligence and care, to produce a tobacco plant which you will not have to sucker, as we express it; which will save all that expense, and which will be just as good. But I am spending too much time on this branch of our work and must hurry on.

I meant to mention another line of our work which has been talked of a good deal, and that is in the production of a new strain of orange. The newspapers have been telling you people up in the North that you could grow oranges up here. I even had letters from people in Canada asking for some samples of this hardy orange-tree adapted to grow in a cold climate. Now, unfortunately, all newspaper stories are not true. I give them credit for trying to tell a thing in the right way, but they occasionally stretch it a little. The fact is, in this connection, that there is a little grain of truth which afforded some foundation for the story which went out. The Department two years ago was able to announce that it had produced a hardy orange that could be grown further north than any existing variety. We were able to distribute last year to about five thousand farmers in Georgia, Alabama, Mississippi, and in the region running through there to Texas

and the Indian Territory, a type of orange which we believe will grow in those localities. The orange is not adapted, as of course you all know, to a cold climate. This fruit will not appear on the Boston market tomorrow. It is not even an orange of commerce, but it is an orange which is edible, which produces a marmalade which is first rate, which produces the finest preserves I have ever seen, and which produces equal to the best lemonade which you get from acid fruits. But that is not the whole thing. We have the apple here at home, but in this district to which this orange is adaptable they do not have it. To the people of Georgia, Alabama, and the Carolinas, and all through the northern belt of the southern states where they lack an acid fruit, and where they have to buy apples from the north, if they have them at all, oranges there such as I have described, will come as a great boon.

The Department has spent a great deal of time and money in the importation of valuable productions of other lands. Since Secretary Wilson entered the Department we have had men who have made that their business. There was not originally an office for the importation of plants from other countries for introduction into this country, but now we have men scouring all parts of the earth for the purpose of getting hold of productions of value which can be transplanted here. Many of the most valuable fruits which we have were originally brought from abroad. These have been secured and brought over at various times during the last two centuries. Comparatively recently several valuable things have been obtained. Take Durand wheat, which is a good illustration. You might say that it would be strange that we should find in benighted Russia a wheat which would be valuable to us, but the so-called Durand wheat, which is essentially a Russian wheat, was not imported into this country until lately. The Department sent agents to Russia to study the industry over there, to study into the methods of its cultivation, etc., before it was sent over here. Now the Durand wheat is very hard. It differs quite a little from our wheat here. It yields more heavily as a whole, and contains more gluten, and, all things considered, it has quite a number of points which make it more valuable than our present wheat. It seemed to be doubtful, for certain reasons, whether we would succeed in importing the

Durand wheat, but in 1901, in the northwestern region of this country there were produced nearly fifty thousand bushels of that prime wheat. Last year, in 1905, there was grown over twenty million bushels, and all the farmers who have tried it have found this wheat to be a better yielder and to be thoroughly adapted to their conditions, and it is established now in this country beyond doubt.

We have also imported from Sweden a very fine oat which is a heavy yielder, and fills out well. It has been found that this oat was a substantial addition to our native stocks. We grow today nearly four million bushels annually of those oats.

We also sent a man to Japan to study rice, and have imported some very fine varieties of rice. We imported one of the Japanese varieties which bids fair to supersede the variety usually grown in Texas and Louisiana. It has been found to be well adapted to that region of our country, to be a good yielder, and grows well in the southwest.

One of the interesting lines of work which the Department has taken up, one which I personally enjoy, although I do but little of it, is what we term "farm management work." I know every farmer thinks he knows how to manage his own farm, and we all know that the farmers of the country are succeeding in managing their farms very well, so that they are being made more and more profitable, but, at the same time, we know that John Jones over here in one county is a fine farmer, and we know that Joe Smith over here in another county has a good farm but does not seem to be so good a manager, and we think that if we can get John Jones and Joe Smith together and let them talk over with each other their various methods of management, good will result. That is what the Department is trying to do. We are sending men to successful farmers here and there, studying their methods, and then publishing papers detailing exactly how they have gotten certain results. All that has proven helpful. By reason of these methods we believe that most farmers can improve on the methods they are pursuing today, or, at least, get good suggestions from it. We all know that if a man enters into a business with which he is not perfectly familiar he wants to go to a man who is successful in that industry and learn from him just how he succeeds, how he carries it out, and the more a farmer can learn the more he will enjoy his work, and, of course, the more successful he will be. If we can bring to-

gether this knowledge from every successful farmer and make it available to all the farmers of the country, we believe that that will be a very helpful line of work. That is one of the things that the Department is trying to do.

Now aside from these that I have mentioned, the great bureaus of the Department, we have the bureau of forest service, but I notice in looking over your programme that you are to have a talk on that particular subject and I shall not take the time to speak of the details of the work of that department.

Another bureau is engaged in soil surveys, and we also have the bureau of entomology, the bureau of statistics, and several other bureaus which I shall not mention in very great detail.

Probably you are all familiar with the work of the bureau of soil surveys. One of the primary objects of that is to study the soils where crops are grown, and map those soils out so that a man unfamiliar with the soil may be able, by taking the map, to find where certain types of soil adapted to certain plants exist. This work has been going on for several years. Very large areas have been mapped in all the principal crop regions of the United States. Cotton soils, tobacco soils, apple soils, and soils adapted to the growth of many different crops have been more or less studied and exactly mapped. Now this brings that bureau naturally to the study of soil fertility and soil cultivation, and they have given us some new suggestions relative to soil fertility that I believe will be of great value.

It is not necessary to dwell upon the work of the bureau of entomology. All of you have probably heard of the work which this bureau has done in connection with the boll weevil which is affecting the cotton of Texas and adjoining states. When the foot and mouth disease was introduced here Congress made a special appropriation of \$500,000 for the purpose of studying and stamping out that disease. When the boll weevil came up from Mexico into Texas and attacked the cotton crop, threatening its destruction, Congress made another emergency appropriation for the study of this pest and its control, if possible. Now, unfortunately, inasmuch as we have to deal with millions upon millions of these little fellows, extermination seems practically impossible, and we have been obliged to turn our attention to the study of some other method besides extermination in order to secure the needed protection for the

cotton crop. The Department experts almost over-ran Texas. They have studied every phase of the boll weevil question imaginable, from the use of this machine to the use of that, and from the use of this spray or that spray, and have worked out every idea for its control that could possibly be suggested by the three million people that live down there. Unfortunately, we have found no absolute remedy for this pest. However, as the result of all this study there has grown up a policy which, at least, is giving fairly good results. It was found, as a matter of experiment, that the early variety of cotton, when planted as early in the season as possible, and cultivated thoroughly, would give a crop before these little pests became abundant enough to do damage. Therefore, the result of this study was simply the discovery of this simple method for treatment of the crop. Coupled with this use of early varieties and early cultivation, it was found that by cleaning up the fields, and burning up the old cotton stalks, etc., it would destroy large numbers of the pest. That knowledge has been spread broadcast all over Texas and in the adjoining region afflicted with it. The interest in the matter down there is simply intense. During the last political campaign it was said that it was impossible to get the attention of the people fixed on the election because they were so intent in discussing the boll weevil. You could go into most any town in that district and find groups of men who instead of talking politics were talking about the boll weevil, and the new idea of overcoming the trouble by better cultivation. Now as the result of the efforts of the Department Texas has made a decided advance. There has never been such a quick acquisition of knowledge on the part of the growers of any crop, and I venture to say that the farmers are better informed in regard to advanced methods than in any other industry of like kind. While we have not been able to absolutely control the boll weevil, we have been able to show the farmers that they could produce a crop with the boll weevil all around them.

The other lines of work of the Department probably need not be mentioned this morning, but just a word in regard to the dissemination of knowledge. You are all probably familiar with our year book, in which we bring together special papers on special topics. It is a book of from eight hundred to a thousand pages, and is published in editions of five hundred thousand

each, the largest edition of any Government publication. That goes to the farmers all over the country. It also goes to the libraries, as it constitutes a valuable work for reference, and is thus made accessible to every farmer in the land. We also publish a farmers' bulletin, which goes all over the country. It is distributed broadcast. We are attempting in every way possible to coöperate with the experiment stations and with the farmers' institute work. Many of our men are delivering lectures and talking in that way.

I may say that our methods are undergoing something of a revolution. You have perhaps heard of the famous corn trains of the West, of the vegetable trains, apple trains, etc., which have been utilized as a means of spreading knowledge of these crops. I never realized what a success those trains were until I was detailed on one of the corn trains in Iowa last season. The value of that method for distributing knowledge simply depends upon the simplicity of the facts which are being taught. Let me illustrate that. I joined a corn train in Iowa at Sioux City in February of last year. On a Monday morning we pulled out from the station in Sioux City running south. It was snowing very hard. You could hardly see across the street. There were at least two feet of snow on a level. When we pulled into a little station with probably not more than a couple of dozen houses I never was so surprised in my life as I was to see teams lined up for almost half a mile about that little station, and I would be willing to wager that three carloads of people were packed into a small space waiting to be addressed. There were so many of them they could hardly get in. At every station we visited that day, and I think it was fourteen different places, giving talks of half an hour each, we had from four hundred to five hundred people present. And that in spite of the inclemency of the weather. Such a movement under the direction of the State Board of Agriculture, and of the Department, in conjunction with the experiment stations, is certainly of the greatest value in enabling us to bring to the farmers here and there information which they otherwise would never get. It savors of political speaking from the back platform of a train, but I believe that men will attend those trains that never would attend a farmers' institute meeting. The Department is endeavoring to aid in this movement so far as lies in its power.

I can say no more, I believe, this morning on account of lack of time, but I would like to say in conclusion that in connection with this work which the Department is doing if you can glean some idea of its immensity and at the same time get some realization of the importance and dignity of farm life, I shall certainly have succeeded in my mission here. The Department is advancing all means of knowledge on agricultural matters in a way never before undertaken, and if we are to keep our sons and our daughters on the farms, if we are to interest them and keep them there, as I believe we should in this country, we must give them something to do; we must give them something interesting. If we can place in their hands knowledge which will serve to interest them in farm work and hold them upon the farm, we will accomplish an exceedingly useful thing. In this connection I remember a little story of Burbank, and you all know how the name of Burbank as a plant breeder has spread over the country. You have heard of the Burbank potato. Burbank describes the origin of that in this way. He was familiar as a boy with the original Early Rose potato. He knew of the methods that had been pursued because he had talked them over with well-informed people. He was a student in this region, and was going to school. He said that his uncle had a patch of Early Rose potatoes, and he had to pass through that patch every day on his way to school. He was always interested in the matter, and he began to look for seed balls. Now you know the Early Rose is not a prolific producer of seed balls, but one day he came across a plant that had a couple of seed balls developed upon it. Why, he said he watched those seed balls with the greatest interest every day. Every day he said he would walk by them watching intently for one of the balls to fall. One morning when he went by he looked at them and noticed that one had gone. He said that he felt like crying over the loss of that ball. He hunted for it but could not find it. He said that he could not give it up, and every day for a week he said that he went back to the place and searched for that seed ball and finally he said he found it some distance away from the plant, where some animal had passed rapidly through the patch and the ball had been knocked from the plant. Now being familiar with the work in plant breeding he took the seed ball and from that progenitor produced the results obtained in

the great Burbank potato. He said that little incident led him to take up his life work of plant breeding, and led to his success entirely. Now what was accomplished by Mr. Burbank may be done by every boy. Any farmers' boy may take up the same kind of work, to improve the crop, may select his seed carefully, and by proceeding in an intelligent way, produce something of value to the community.

Now every item of knowledge that we can add to this industry is a help to all. If we can make it an exact science it simply makes it all the better, more interesting, and more enjoyable. We cannot learn too much. That is what the Department of Agriculture is doing, and what your State experiment stations are attempting to do. How well they are succeeding I will leave you to judge.

I thank you for your attention.

The PRESIDENT. The time for adjournment has very nearly arrived, but there is an opportunity for questions for a few moments, if any of you desire.

Mr. PLATT. Can the Doctor tell us if the Government is doing anything towards controlling the gypsy moth? We hear a good deal about it in our neighboring states, and it may be very near us for all we know.

Dr. WEBBER. In answer to the gentleman I will say that they are working with it, but relative to the results I am entirely uninformed. If you will address a letter to the Bureau of Entomology at Washington they will give you a bulletin and all the information they have on that subject. I am not sufficiently informed to give you the details.

Mr. SEDGWICK. I would like to inquire of the gentleman if the Department is investigating the potato rot? What is the cause of that?

Dr. WEBBER. They are investigating the potato rot very thoroughly and investigating it in a very interesting manner. The Department is trying to produce an immune strain. We started work three years ago, I think it was, in coöperation with the Vermont station, by the importation and testing of foreign varieties of potatoes. I believe that every potato grower has probably observed that certain varieties are less susceptible to that disease than others, and we have knowledge which has come to us of foreign varieties which are immune. We have imported some of them. We sent Professor

Jones of Vermont abroad to study those varieties and to import some of the seed. We imported seed from all the good varieties from Scotland and from other countries, those are all being carefully studied, and we hope, although it is a matter of the future, but we hope we shall be able to place in your hands varieties of potatoes which shall be immune to this disease. Of course, the stations and the Department have also been working along the line of prevention by the use of various washes and sprays. The use of formaldehyde and the corrosive sublimate treatment is probably familiar to the most of you, but we hope we shall have an immune variety, which, of course, will be by far the better thing.

A MEMBER. Mr. President, I am not specially interested in the subject of tobacco, but there are some tobacco growers here, and in speaking of shade-grown tobacco the speaker said that that is practically a failure. I want to ask if that is not because it is grown under shade: if it is not because it is grown without the sun and does not come out well any more than grass does that is grown under shade?

Dr. WEBBER. The gentleman has asked a mooted question. It is true that a leaf grown under shade is very thin. You are, therefore, fighting with the manufacturer. The manufacturer, on the one side, wants a leaf from which he can cut the greatest number of wrappers, the greatest number per pound. On the other hand, they are liable to get so thin that they break up on the cigar. Now it is believed that the product in Connecticut is rather thin, and, as I understand the matter, in the experiments this year which have been conducted on various lines, they have attempted to correct this in a certain measure. Possibly, it may be done by removing the tent a portion of the season. It is well known that the plant developed in the open sun has a tendency to thicken. The trouble is that there a leaf is produced which is too thick. We have got to reach a mean between those two. We have two ways of doing it. We may be able to accomplish it by removing the tent for a portion of the time. I do not know whether that will be successful or not. It is a matter of experiment. Then again we may be able to do it by breeding, in the same way that one plant produces a lot of suckers and another plant develops none of them. In the same way, one plant will produce thick leaves and another thin. If

these leaves are too thin, I believe we can produce a thicker leaf by a process of selection and breeding. The industry at the present time is simply in a stage of development. I may say, however, for the gentleman's information (if he does not already know it) that there are a good many things to recommend Sumatra shade-grown tobacco. Whether the market will take what we will be able to produce here I do not know. I have not been concerned with this experiment except from the standpoint of breeding.

The PRESIDENT. These remarks by our speaker bring this suggestion to my mind in regard to that. What do you wish of tobacco? If I grow grass under shade my horses or my cows know the difference between eating that grass and that which is grown out in the sunshine. I do not know what may be desirable, but probably the taste may have something to do with it. Those who love tobacco can tell about that better than I. It may be that that is the question, whether the man who uses that tobacco will like the taste, or the man who manufactures it can wrap more cigars with it.

The hour for adjournment has arrived. This convention will stand adjourned until two o'clock this afternoon.

AFTERNOON SESSION.

Tuesday, December 12, 1905.

(Music.)

Convention called to order at 2.00 P.M., Vice-President Seeley in the chair.

The PRESIDENT. By your programmes you will see that we are to have an address this afternoon on "The Essentials of Success in Future Sheep Breeding."

Now there has from the earliest times never been any better or more honorable occupation than the rearing and caring for sheep, and we have hundreds of acres here in Connecticut which I have not the slightest doubt are well adapted to the rearing of sheep, and would make it a most profitable industry under proper rules and regulations, and system. Perhaps better than anything else that much of that land can be used

for. I am very glad this afternoon that we have a gentleman here who is well posted, as I understand, in rearing and caring for sheep, and it gives me pleasure to introduce to you this afternoon this gentleman, Dr. C. D. Smead, of Logan, New York.

"THE ESSENTIALS OF SUCCESS IN FUTURE SHEEP BREEDING."

BY DR. C. D. SMEAD, Logan, N. Y.

Mr. President and friends: It affords me a great deal of pleasure to meet with you in your mid-winter meeting at this time, because I expect to learn something of you, a great deal more of you than you will learn of me. Therefore, it affords me pleasure to be with you. I have always in my life endeavored to learn something and have not made a very good success of it, but such as I have learned I shall endeavor to impart unto you.

The President has stated in his opening remarks that in his boyhood days he tended sheep, large numbers of sheep, and became disgusted with sheep and quit the business, as I suppose, resolved at any rate that he would have nothing to do with it. Now I am very sorry indeed that he did that, and I am more than sorry that others have done the same thing. Why? Because, as a matter of fact, the sheep industry of the world today is in a deplorable condition. There is no denying that. You who have given the matter thought and study, looked up the statistics, realize as well as I that there are less sheep in the world today than there have been at any time in fifty years; and the worst of it is they are growing less and less rapidly, and your clothes and mine are wearing out proportionately, and it is certain, Mr. President, that unless a change takes place, which I have faith to believe there will, it will not be long before you and I will not be finding fault with our wool but, as a matter of fact, we will be pretty glad to get it to wear. Our agricultural department at Washington has taken a great deal of pains in conjunction with other countries of the world where sheep are kept in looking this matter up and have now reported that at the beginning of this

year there were ninety million less sheep in the world than there were in 1873. There has been a steady decrease then of three millions per year since 1873 in the whole world. A more deplorable thing than that is that there has been a decrease of ten millions of sheep right here in the United States since 1900. Now taking into consideration that fact, and taking into consideration the fact that the sheep of today will be, after the usual lamb crop is disposed of by the first of March or April, above six years of age—and six years is about the age of usefulness—and you can see that we are pretty near on the verge of a sheep famine. It seems, farmers, that it becomes the farmers of the whole United States, not simply the farmers of the State of Connecticut, or the New England States, or New York, Michigan, Ohio, Pennsylvania, or other states where they have been keeping sheep, to see that this is really a serious question, and that the whole United States should be interested. Why? For several reasons. We cannot, in my judgment, and I believe you will agree with me in that, we cannot safely and profitably prosecute farm work in the New England States, or in the states of New York, Pennsylvania, Michigan, and Ohio, at any rate, and I know that it is so in those states because I am familiar with them,—I know that we cannot carry on our farms as we should without we keep some sheep, so I will put it down as an essential thing, as the first essential thing, keep some sheep on the farm. Why? As I came down through Pennsylvania yesterday, and Southern New York, and saw the weeds growing up in the pastures in the dairy sections of Pennsylvania, that the sheep would eradicate and turn into mutton, I could not help but feel that a mistake was being made. Now take into consideration the fact that for the past ten years what we call hothouse lamb has sold on the average at \$9.70 per head year after year in the markets of New York, Buffalo, and Chicago, and yet from the lack of a few sheep on the farm many of you have been allowing that money to get right away from you into some other places that could have been added to the income of the farm. I say the first essential then is that a few sheep should be kept on every farm, whether it is a grain farm, a fruit farm, or a dairy farm for the purpose of rooting out the weeds and turning them into mutton. As I travel over my own State

of New York I can pick out the farms by the weeds where sheep have been kept all these years. You can tell where they are.

I have been for some years engaged in the farmers' institute work in the State of New York, and at every meeting the vital question that comes up in the dairy section is how to regulate the pastures that cannot be tilled. Weeds of various kinds are growing, coming into them continuously, and the question has been, what are we to do? What is the answer? Why the answer is, keep a few sheep. Now I know that some men within the hearing of my voice say they will starve out the cows, but are you, my friends, so sure of that? If a man has over-stocked his pasture, put a few sheep upon it, put them on with the cattle, and I will guarantee you they will come out ahead. If a man will keep a few sheep with his dairy herd of cattle he will be surprised to find that they will make a more luxurious pasture for them. I know that because I have had that on my own farm. I have tried to study these matters, and I have found by experience that a few sheep running with my cows upon the farm will take the weeds out of my pasture and clean them up so as to allow other grasses grow up that are relished by the cattle. I have improved my own farm in this way, and I could show you a pasture that has been occupied with sheep and cattle side by side running together for the last twenty years. It is as fine a pasture as you could find anywhere, and that has been brought about largely in that way.

Now before we talk about the essentials let me say that we sometimes can learn things by taking a back sight, as surveyors say; or as civil engineers say in running out country lines we will take a back sight to know whether we are going in the right direction or not. Now let us take a little back sight of this industry. What has brought about this condition of sheep culture today in this country? There is not a man who has a flock of sheep today, I believe, but what will bear me out in the assertion that if he has taken care of those sheep he has made some profit for all the time that the flock has been in existence. Now I am not going outside of the United States only as far as to say that in Australia, a great sheep country, owing to the curse of rabbits and the curse of locusts, large flocks of sheep have been decimated. The same has

been true in other parts of the world, but for the purposes of this talk we will confine ourselves right down to the United States. What was the condition of the sheep industry, Mr. President, when you were a boy? I will venture to say that there were not in your boyhood days to exceed five thousand sheep in the whole United States that were not merinos or of merino grade. At the outbreak of the Civil War there came a demand for a class of wool that had not existed to any extent in this country before. It was needed for the purpose of making army blankets for the soldiers. There came a demand for some of the coarser wools. The coarser wools went up in price. There was a large increase in the demand even for the gray merino wool. The price went up steadily, and then there began what we will call a revolution of the sheep industry of this country, beginning as it did with the outbreak of the Civil War. At that time there came a tremendous demand for the coarser classes of wool, and with that large demand a great increase in the price of wool, but at the close of the war when that demand ceased, of course, the coarser wools began to go back. There was no demand for them. Something else took place and that something else was this. The high price of wool stimulated the breeding of the merino sheep as never before. I feel proud to say, and proud of the American merino breeders who today produce sheep that stand pre-eminent as the best wool sheep above any other country on earth, but in the race to produce that American merino sheep our breeders did something that brought about a change in the market. It was something that all of us are apt to do when we get a little too enthusiastic. We sometimes overdo. I know I do when I am on the platform. I sometimes go a little too far. I hope I shall not in this. I do not want to trample on any one's toes in what I am about to say. But in the stimulus of breeding these wool sheep shortly after the close of the war, or about 1864 or 1865, and from that on, as the result of the stimulus to this breeding, merino sheep instead of producing about five or six pounds of wool per fleece the breeders actually increased the wool producing power of the sheep very materially. They began to produce heavier fleeces, which brought them into prominence. Here is where a mistake was made by New York and Vermont breeders, and perhaps also by Connecticut breed-

ers. The sheep developed a stronger constitution, they bred more wrinkles in them in order that they might have more surface and so get more wool, and in order to get weight they bred for size. Shearing festivals were held all over New York and I believe in New England. The weight of the fleece came to be the dominant factor in shearing. It was the weight of the fleece that counted, and it kept going up and up; instead of getting an old-fashioned fleece we began to get fleeces which weighed anywhere from ten, fifteen, twenty, to twenty-five pounds each, and occasionally some one would shear a fleece weighing thirty pounds or thereabouts. Then what happened? When the manufacturer took that fleece and scoured it down to about six pounds, he did not feel as though he could stand the racket. There is where the trouble commenced, friends. The manufacturer could not afford to pay for twenty-five pounds and then have it only come out after it was scoured weighing about five or six pounds at the extreme. What did he do? Sometimes a slight thing will change the fashion. At that time there had been^e brought into the United States with the coarse wools that we have been speaking about some of the medium wools, such as the Southdowns, and a few of the other Downs, the Leicesters, a long-wooled breed, had been brought over. Under the stimulus of the prices which had been obtained for wool they had been brought over. Now this manufacturer, he says to himself, I wonder if I cannot put in a little of that other wool and thereby reduce my cost? Everybody at that time, Mr. President, wore a broadcloth coat. I know they did in New York, and I suppose they did in New England. As a matter of fact, most everyone wore broadcloth previous to 1871-2-3 for a dress suit; yes, and the ladies wore merinos very largely. This manufacturer began to wonder if he could not get out of the hole that he was being driven into by introducing a little Southdown wool, and some of the other medium wools that he could get. Then what happened? Why, he purchased that wool, used it in his product, the trade liked the class of goods that he turned out, liked it because they wore pretty well, and the broadcloth suit was changed for what was called tweeds and cheviots, and things of that class, until today we have got to have a fellow that goes pretty well dressed up if he has a broadcloth suit. Then what took place? As the fashion changed over came the South-

downs, the Shropshire Downs, the Hampshire Downs; and Leicesters and the Cotswolds all came to this country. Down began to go the price of merino wool. Merino wool dropped down and down, and the result of it all was in plain language that these British breeds of sheep, by reason of the change in fashion, almost drove out the American merinos. They were driven away from Vermont, and perhaps Connecticut. I am not as familiar with Connecticut as I am with some other sections. They were driven from eastern New York to western New York, into Ohio, and so on down into Texas, and away on to the ranges. They were replaced by some of these English breeds of sheep. Now I am saying nothing against them. I do not wish to be understood that way at all. It is a fact those sheep came here, and the attempt was made to make them take the place of the merino, and as a consequence more failures were made with them, I believe, than successes. Men undertook to buy them, and did buy them, and took them on to their farms and gave them a class of care and feeding that they used to give to the merino sheep, and the result was the sheep went to the dogs, and the dogs did not do the killing either. Those flocks kept running down and down until men who were attempting to breed them became disgusted with them and what did not die were sold off. Now in consequence of that movement, it is a plain simple fact that large numbers of men today are not keeping sheep. They say we tried those and we failed. Now there is nothing against those breeds of sheep. It was simply a lack of knowledge on the part of those that bought them in failing to give them English care. The sheep came to this country but the Englishmen did not come with them to care for them. There was where the trouble came, along that line. I will say to you today that you cannot, friends, if you have been breeders of merino sheep, and I think you have many of you, you cannot take any English breed of sheep and give it the same care that you did those merinos and make a success of the business. They must have a different line of care. British methods must be followed to a great extent or there will be a failure. A breeder who has met a high degree of success with the British breeds is the one who has made a study of the need of the sheep. He has found that he must care for them according to the methods prevailing in England. He

has adopted those methods and has accordingly made a success, while the American farmer that got them and endeavored to breed them, and endeavored to care for them according to the methods he pursued with merinos has made a failure of it. But that is not all, that is not the worst of it. That has been partly overcome. The American farmer has studied English methods until today he is raising and furnishing his flock with succulent food and giving them a little of the care which is needed, and they are succeeding fairly well with them, or did up until about nine or ten years ago. When the English sheep came over without the Englishmen to care for them there came with them something that we knew nothing about here, and I venture to say that previous to about twenty years ago not a man within the hearing of my voice ever saw a sheep louse. I have no reference to sheep ticks now. We had sheep ticks here but they did not thrive very well on the merino sheep. They did not like the mutton, I guess, but they did like the mutton of the British breeds of sheep. I do not know where the ticks came from. They were here. There was however an unseen foe which we had not before that time calculated upon. We could get rid of sheep ticks because we had learned that there were certain classes of poison which were not poisonous to the animal but were poisonous to the sheep tick and the louse or scab mite. Dipping was practiced to get rid of them, became quite well established, until every progressive farmer was able to keep his flock practically clear. After about ten years it was noticed that the sheep were beginning to decline under a disease that was mysterious. Sheep tick, lice, and the scab mite we could get rid of, but as to the other many a farmer was fooled by it and did not know what was the matter. I had a veterinarian make an investigation about fourteen years ago. That was the first I knew about it. I began to hold post mortem examinations, and others were doing the same. As the result of those examinations we found a little infinitesimal worm, the stomach worm, and we found some worms that were in the bronchial tubes. Longer worms. We found along the intestines little nodules. We thought for a time it was tuberculosis. Everything was going to tubercles along the intestines, but under the microscope we found in these little nodules a little worm, so small that we could not see it with the naked

eye, and it was soon established that it was this little worm that was doing the damage. Here another thing took place among the farmers of the east. I believe I may be talking to some who had experience with it while I am speaking here today. There seemed to be a kind of panic in the sheep industry about five years ago, created by this disease, and a good many have not gotten over it yet. The sheep began to decline, and the farmers, instead of investigating the trouble as they should, because it was not a difficult matter to locate, became panic-stricken, and many a man went out of the business. I know that in my own section we had a number of farmers who were knocked out of the business by the worm. The farmers got scared when that worm got to work in the sheep folds, and the result of it was that a good many farms that were profitably engaged in the sheep industry are today sheepless. There is many a man that will laugh and shake his head and say, "I cannot keep sheep," but that is because he has been scared at a difficulty which is not hard to overcome. We are living today in what may be called an age of parasitism, or the parasitic age. If you will stop to consider one moment you will see how it is. Take those apples that are on the table, and I will guarantee that the man who raised them fought parasites in order that he might raise them, and if he had not fought parasites there would not have been any of those apples on the table today nor anywhere else. You cannot raise a hill of potatoes without you use a spray of some kind or something to destroy the bugs. We are in just that condition in the animal kingdom. We cannot raise today anything, either in the animal or vegetable kingdoms, anything from a chicken to a lamb, without we get ourselves into a position to fight parasites. If you raise vegetables or fruit, to be successful you must carry on an eternal warfare against bugs and parasites. If you raise animals, from a chicken up to a horse, you must make up your mind that you must prepare yourself to destroy the parasites, or you cannot be successful. We are living in that age. Now that sounds large. It is not. It is true it involves more labor, but it is a hard fight which confronts us, and we cannot raise sheep as we used to raise them. We have got to take care of them and take care of them properly. We must take care of them as the needs of the time demand. That is the hard fact which we cannot

dodge. We will say then, that the first essential thing is to have some sheep on the farm, and the next, that they must be properly taken care of. In my connection with the *National Stockman*, and other farming publications, I have frequently had men write to me, asking about their sheep. Now what is to be the first essential thing in reviving the sheep industry in Connecticut, or all over New England for that matter, and in New York and these other states? In the first place, it seems to me, Mr. President, that you people here in Connecticut, or in New England, have a great opportunity in this connection which other sections of the country do not possess. I believe that you have an opportunity here of raising sheep so that they will pay you at least forty per cent. more than anywhere in the West. Land can be bought for from forty to sixty per cent. less in Connecticut and Massachusetts, and in most all of the New England States, than it can in the Far West. I know that from my experience in my own business. I have been out in the West and I can tell you that is the situation. I was there this summer and I was there four years ago. So I am not talking through my hat when I say that. It is a plain fact. Sheep can be raised cheaper here than they can be raised at any point east of the Mississippi River today because, first, the investment is much less for land, which is one of the main things, and then besides that, you have water here in abundance, while in the Far West they have a great deal of trouble on that account.

What will be the next thing? I said in the beginning that the sheep of the country, its lambs, that are now bringing from seven to seven and one-half and eight cents a pound, and as high as nine cents for some grades in the Chicago market, — that is, lambs dropped in May, and when they will bring such prices as that many a man will sell them off. The tendency, therefore, will be to sell off the lamb crop. I will guarantee you that because it is the money that the man is after, and ninety per cent. of the 1905 crop of lambs will, in my judgment, be eaten before the first day of next April. Now the first essential thing for a man to do that is getting six, seven, eight, nine, or ten cents, is to keep his old ewes, and to make up his mind that no matter what the price may be next year he will save his best ewe lambs. Now the next essential is this: you must make up your mind that if you cannot raise the sheep

you want on your farm then go into the market and buy lambs. If you find a man that has saved his best ewe lambs and wants to sell them, of course, that is the best thing. The probability is, if that man knows his business, you will not be able to get them. But if you find a fellow that is poor and has perhaps got to sell, buy them so as to have a stock to start with. Now the next thing, of course, is to maintain them. That is one of the main points. They must be properly taken care of, and, as a part of that, diseases and troubles incident to sheep must be taken care of. Of course, for ticks and lice, vermin of that kind, that can be met by dipping. Every successful man will do it regularly. He will make it his business to dip his lambs and dip his sheep in the spring of the year as regularly as he will make it his business to spray his potato vines. Then he is sure that there is no unseen foe that he can discover, except what I am going to speak about in a moment, to interfere with the flock. The best time to kill off lice and ticks is right away after shearing. That should be done along late in the spring. If you shear as we do in New York, it will be usually about May. Some wait until along into June, but quite rarely. Usually from the latter part of April to the first of May is the best time. There is no better time in the world to get rid of lice and sheep ticks than there and then. A sheep has a long fleece and a lamb has a little short fleece, and I believe by far the greater part of such things can be gotten rid of by the right kind of treatment at that time. I have experimented upon it, and I believe almost every one of them can be gotten rid of. There are a number of good sheep dips advertised on the market. The carbolic sheep dips are good because they are non-poisonous. They are non-poisonous to the sheep but they are poisonous to all such insects. Some of the other dips, such as arsenical dips, have got to be handled with care. They will easily kill a sheep. They will kill sheep tick, but they have got to be handled with care. Any one that has had experience knows that it is impossible to dip a sheep without getting his head under some of the time. In the struggle the sheep will go under, and if it swallows any of the arsenical dip or gets it in its mouth it will be apt to make the sheep sick even if it does not kill it. Now why is it there can be dips used which are poisonous to the sheep tick and not to the sheep? The cold tar or carbolic

sheep dips that are put upon the market simply have the effect, when the solution is applied, of choking the tick and lice to death. When you examine these insects with a microscope it is found that they have no lungs, but that air enters their bodies through holes in their sides, and if we put these carbolic solutions upon them it simply puckers up those breathing holes and they choke to death. When it comes to the use of the others they simply make a coating over the animal. They do not kill by contact but they make a coating over the animal, and the louse or tick is poisoned by simply taking a bite of it, just as the potato beetle is poisoned with paris green when you spread it on your potato vines. When a bug takes a little bite of the potato leaf he takes the poison with it.

Now here comes the other thing that I want to speak of. Presuming that you have a flock of lambs, or that you will, if you save your best ewes, then what is the next step in properly taking care of the flock? Suppose that you are just starting now, and that you have got a flock of old sheep to start with; that you have an old flock of ewes such as I have described. Now those old sheep may harbor a number of different kinds of worms. The small stomach worm, a little worm which will perhaps average from three-quarters to an inch and a half in length, and no larger in diameter than a common thread, number eight or twelve. That little worm is doing more harm today than any other worm. The nodular worm will come next in order. Now these are undoubtedly today inhabiting the intestines of practically five out of every six sheep in the whole United States. They have spread pretty well over the whole country. These small worms are today inhabiting the intestines of about five out of every six sheep of the age of the old sheep in the United States, and if they are there in large numbers they will cause the death of the old sheep between now and the first day of May unless taken care of. If they are not there in large numbers they will still do damage. They are undoubtedly present to some extent. While the sheep are off the pasture they are passing from the old sheep and are doing little damage. They are doing practically no harm, but next spring when the sheep are turned out to pasture there will be a passage of the eggs of the worm, or the embryo, on to the pasture fields, and then is the time that the lambs will become infected. Now here

is something that is really amazing. Young animals, and the same may be said of children, are afflicted the most with worms of all kinds. When those worms get into a lamb they accumulate in larger numbers in the lamb than anywhere else. Now the flock will go well with the lambs until about weaning time, and then from that time they will begin to decline. I have had men write to me, "What is the matter with my lambs? They seem to be weak. They seem to be running down. I feed them well, but they seem to be going back. What is the reason of that?" It is simply because they are worm infected. Now let us reason a little about these worms. So far as has been ascertained thus far, the average life of any one of the worm family is only one year. Now we will suppose that those sheep were turned out to pasture. While they are in the barn they are usually doing no harm by infecting the lambs before birth or after birth, especially if the lambs are born in February or March. Before we turn the flock out to pasture we should try to rid the old sheep of the trouble. We should treat the old sheep to get rid of the worms that will later on infect the lambs. How will you do it? There have been a great many experiments carried on at our experimental farms in New York, and I do not know but it has been the same with you. Today, however, it has simmered down practically to two remedies which can be used. With the gasoline treatment, with one thorough application, fifty per cent. of them can be destroyed. The second should destroy at least seventy-five per cent., and the third dose will destroy practically ninety-five per cent. of those worms. The gasoline treatment stands today, in my judgment, ahead of any other. The next one is a cold tar product, and is called creosote or creolin. If the sheep are dosed with that previous to being turned out to pasture the old sheep will be pretty free of the disease. I know by experience that that is so. I have lost a lot of sheep with worms. I have learned that to be successful some treatment for this difficulty in the spring is absolutely essential. I have learned to give them a dose of gasoline before they are turned out to pasture. A dose of gasoline is a tablespoonful. A dose of the creolin is one teaspoonful. Now if I was to stop right there and simply say, give your sheep this treatment before turning them out to pasture, a tablespoonful of gasoline, you might use it, but I will guarantee you would

hoot me off this platform if I ever came here again, because I will guarantee that the first sheep you tried it on you would have trouble on, and you would not go through the flock. There is a right way and a wrong way of using the treatment. There is a right way and a safe way of giving gasoline. Put into that tablespoonful about two tablespoonfuls of raw linseed oil, and then add to that at least four tablespoonfuls of milk. I do not care if you make it a half pint of milk. I do not care how much milk you put in. Some of the experiment stations in the West have said to use gasoline and milk. I would not dare say that on the platform or say it through the press or privately. I would not dare to mix gasoline with milk and give it to sheep because there is too much of a fiery nature in it, and if any mistake was made it would be apt to kill the sheep. Mix the gasoline first with oil. The oil acts also in another way. It is a mild cathartic, and when the gasoline affects the worm a little cathartic crowds him out of his home and the first thing he knows he is on the earth. The oil takes off the fiery effect. Now I said there was a right way and a wrong way to mix gasoline. First, mix it up in that proportion so that the sheep will get a tablespoonful. I do not care how you make it, but put in two tablespoonfuls of raw linseed oil, and at least four tablespoonfuls of milk, or more, if you wish. Put it up in a bottle, and keep the bottle tipped up until the dose goes down the sheep's throat. Of course, some have difficulty in administering the dose. I have been called out of the State of New York to see flocks of sheep that were dying, and I tell you I have learned a lot of things about human nature along this line. One of the things which I have done in such cases has been to fix up a dose and then say to the man whose sheep I was inspecting, "Now, Mr. — will you please give this sheep this dose," and what have I seen? I have seen a two hundred-pound man grab a seventy-five pound lamb, get him up, and raise his head so high that the lamb could not swallow to save his soul if he had one. He would kick and struggle because when the man had elevated his head above certain degrees of elevation it became impossible for that lamb to swallow or breathe, and the man was simply strangling him to death. And then the man would say, "Confound that gasoline treatment, it has killed my sheep." Now it was not the fault of the treatment.

It was the ignorance of the man. He simply did not know how to administer the dose. I have seen them grab a sheep and throw it down, and then try to ram the bottle down the sheep's throat, ram it down as far as they could and pour that down the sheep. I have heard men say it is almost impossible to give medicine to sheep, but that is not so at all. The right way is this: Take a sheep and simply set it up as though you were going to shear it. Then you do not have to elevate its head, but simply put the hand under its muzzle like that, and the sheep will almost drink the medicine right down out of the bottle. Shake the bottle at times, keep the bottom well up, and pour it down. If you pursue that course, then you can dose them with anything you wish.

Now there is another thing about the gasoline treatment. Gasoline is of a gassy nature, — and perhaps I ought to say that there is practically little or no difference, so far as the effect is concerned, between the creolin or creosote, call it whichever you are a mind to, because the destruction of the stomach worm is accomplished, but I have been convinced by experiments, and without going into details, that the gasoline by itself, being of a gaseous nature, will permeate into the intestines to an extent that the other will not. I have been convinced that no other remedy at present known is apt to reach these lung worms. Now in case a sheep has all three of these worms I have described, we would probably entirely destroy all three by giving creolin. You may have read this. It has been published in the papers, but they sometimes get things wrong. The creosote or creolin treatment, and that is the way it is called in the drug stores, is usually given a teaspoonful at a time in half a pint of water, the mixture being shaken up well, and then it will stay mixed. It is usually given and it will destroy stomach worms.

After a flock of sheep has been treated in this way they can safely be relied upon as free of worms. If you use the gasoline treatment it is better to give it three mornings in succession. Feed them very early at night, and then give them a dose in the morning before they are fed. Follow that up for three mornings, and you will get rid of fully ninety per cent. of the nodular and stomach worms. Then we have safety.

Now comes another thing. We are not always sure. These worms will live, or the eggs will live, we do not know which, over winter, and infect the pasture. Keep in mind the fact that an old sheep is most likely to be always more or less infected with them. To be safe then, under the circumstances, wherever it can be done, it is better not to pasture the same field two years in succession. Many a man, however, is not fixed so that he can do that. He has got to use his pasture every year. If he is going to keep sheep he wants to keep them on it. If such a man will provide simply a covered box of salt, the box being covered so that the rains will not wash away the salt, but so that the sheep can get their noses into it, and with four quarts of salt mix a gill of turpentine, it will have a good effect. I remember when I was a boy that my father on Saturdays when I was not attending school would say to me sometimes, "Bub, I guess we better go to the woods. You are at home, and I guess we better go and get some pine saplings. The sheep need something green." You do not do that. Now we should notice this fact, that a sheep would be his own doctor if he could. We had some of these worms back in those days, but by just such treatment as that our fathers really kept them under subjection. My father and your father thought sheep needed something green to gnaw at, and therefore furnished them with that kind of material. Now we know why they went for them. It practically kept them clean of the worms. You accomplish practically the same purpose with the salt and turpentine. When you mix the turpentine with salt and put it in an infected pasture the result is sure to be good. I have been surprised when carrying on experiments with a flock of sheep that I knew had worms to see how readily they would lick up my box of salt with the turpentine in it, and to see how much more salt they would eat when the turpentine was in it than when it was not. Therefore, if you will provide the flock with that box of salt, it is one of the best things you can do. When that is done we can pasture year in and year out, in my judgment, so far as these worms are concerned. While this treatment will not kill the long worm it will so saturate the system with turpentine that when the little fellows hatch out they will not live long.

Now there is another thing. It is an unseen foe. Every sheep today needs looking over. The sheep of today need

attention when they did not need it in your boyhood days or mine. If a man has a flock of sheep, and especially if he has a lot of lambs that look a little unthrifty, dose them. It is not a serious job at all. If you want to be successful in raising sheep you must take care of them and pay the same amount of attention that you do to be successful in other lines. If that is done, our farmers in New England and New York can just as well raise sheep profitably now as they ever did.

The outlook in this country for sheep, as the President has intimated, has never been as good as it exists today. The demand for mutton has never been satisfied. It never will be in your day or mine. The price of wool has reached a solid foundation, and will remain. There is nothing that we can see to cause us worry in other countries. We today stand pre-eminently triumphant with our sheep, and there is no reason why we cannot come to the front in the sheep raising industry if we will. Not in your day or mine will you see wool back where it was without the fashion changes and we go without clothes. We need have no fear of that. The tide of emigration is largely towards this country. Thousands of those people are farmers. It is building up the livestock industry in the east. The western sheep industry has had its day. As an industry it is badly handicapped. Those great free pastures in the west exist no longer, and the lack of water is a serious drawback. The stock-raising opportunities for the farmer of the east never were so good in the world as they are today. With the cheaper land, and with the advantage of water, such as we have in the east, the west cannot compete. I have a friend in Iowa, and from letters that I have received within a few days I learned that the problem of today with western farmers, with land worth from seventy-five to one hundred dollars an acre, is how can they compete with the east in raising stock. That is their great problem today. You talk about western competition! It does not exist. They are actually fearing today eastern competition with your lower price of land, and the tremendous advantage which you have in having plenty of water. We who live in this eastern country do not know how to appreciate water. I want to tell you a little story and then I am going to stop. I alluded to the fact that I was engaged for months in studying the situation and in lecturing to farmers' institutes. I went up into that great country lying on the

Red River of the north, taking in a part of North Dakota and South Dakota, and went away up to the Manitoba line trying to study the situation. While there I met a professor with a Norwegian name. He was with us. I simply could not make those people understand the situation. It was the hardest thing in the world. Finally, I said to that professor, "Professor, I want you to come down into New York State and make us a visit. It is your business to do so, and it is your duty to do so. He was western born and bred, but was a college man, and had never been east of Chicago. I said to him, "Away down east they don't know whether you walk on two feet or four," and I says, "now you come east. If you will come and do a little institute work in New York you certainly should do so." He came. We had a meeting at Cornell University, and then we started out. The first place lay about six miles off, and to reach it we took a livery team and started to drive. When we were about half way the driver drove up to a watering-trough. I noticed the professor. He looked amazed. He turned to me and he says, "Where does that water come from?" "There is a spring back here in the hillside," the driver says, "back here about eight or ten miles." "Why," he says, "does that run all the time?" "Why, yes," said the driver, "it is a never failing spring. There is always plenty of running water there." Well, I noticed he looked a little bit curious. He didn't know whether that was right or not. Finally he said, "Is there any other such spring as that in the State of New York?" "Why," says I, "we can count them by the tens of thousands." Well, he never accused me of lying before, but he came pretty near it then. "Well," I said, "I want to have you believe me, and if you will stay here a month you will be convinced of it yourself." We rode along for a little ways, and says he, "Doctor, I don't know what you people are thinking of. If I had that spring anywhere in North Dakota it would be worth ten thousand dollars."

We do not think of this advantage of water. (Applause.)

The PRESIDENT. Now, gentlemen, do not be a bit bashful about asking questions.

QUESTION. What do you do with the dogs in New York State?

Dr. SMEAD. We have some trouble with dogs in New York. They have killed a few sheep. I have learned this, in

controlling the dog question, that when there is a determination of a man to do so he can beat a dog every time. Whenever there is a determination by the sheep growers to control the dog question it can be done. That is the case all over the whole country. Dogs, while they are killing a few sheep in the State of New York, are not doing serious damage, and the damage that they are doing today is largely in sections where there are but very few sheep. A dog has got to be educated to get along with sheep. The regular sheep-killing dog, however, is a sneak thief. He does not like noise. If you will put some bells on your sheep they will give a good deal of protection. They will not afford complete protection, but there is something about a bell that will afford at least seventy-five per cent. of protection from dogs. If you will get some small-sized cowbells and put them on they will create quite a racket. I have had quite a little personal experience with that. I always have at least fifty bells on. They are good fair sized cowbells at that. A few years ago at about eleven o'clock at night those bells began to make a racket. It attracted attention. There was a hound that got into the flock. I met him the next day and the hound ceased to exist. That was simply because there was a sentiment of the people against that kind of work. I do not know what your law in Connecticut is, but in the State of New York it is provided by statute today that any man has the right to shoot any dog that is caught either killing, worrying, or annoying sheep, without he is set upon the sheep by the owner or by his consent. Something like five years ago that law was extended so that now if the dog is even found chasing the animals a man has a right to shoot the dog in the State of New York. Dogs, in the State of New York, are recognized as property, and it behooves a man to take care of his property. If a man does not he is liable for damages.

QUESTION. What do you do where sheep have worms in the head?

Dr. SMEAD. Worms or grubs in the head do not kill one sheep where they are supposed to kill fifty. That may sound like a strange assertion, but the fact is that grubs in the head are not a dangerous foe to sheep except in locations where the gad-fly is extremely numerous. Grub in the head is sometimes due to a lack of grub in the stomach. Where there is no attempt to provide the proper variety of food, or where there is an attempt to winter sheep upon timothy hay, or where the flock is kept in such a way so that they are liable to contract colds and weak lungs, then if the sheep have an excessive number of grubs in the head they will frequently destroy the sheep. I have never yet found a sheep that was actually killed by grubs in the head. I mean from that as the direct cause. I have always found some other contributing cause. In localities where the gad-fly is numerous it is well to use some of the various remedies to keep away the fly.

QUESTION. What is your opinion of ensilage as a food for sheep?

Dr. SMEAD. My sheep eat ensilage every winter. In this climate sheep need a food of that kind in winter, and I have learned by experience that ensilage will supply that need. It is not well to feed too much of it. Ensilage should be fed in the proportion of about two pounds of ensilage to a hundred pounds of sheep. With a sheep weighing 150 pounds, three pounds of ensilage per day is plenty.

Mr. PLATTS. Mr. Chairman, we have had lots of instruction how to take care of sheep, how to protect them from disease, etc., but the trouble with us in Connecticut is our inability to protect them from dogs. It is simply dogs and nothing but dogs. I live in a town in the southern part of the State, and when I was a boy sixty or seventy years ago nearly every farmer had sheep. At that time I rarely ever knew of sheep to be killed by dogs. At the present time, so far as my knowledge goes, there are no sheep kept within ten miles of me. Until within a very short time it has been a continuous

struggle to raise and keep them. I gave up the business many years ago. When our factory villages grew up, and factories paid pretty good wages to their help, and thereby attracted a class of help which kept more dogs than poultry, and my farm being located about two miles from two of these manufacturing villages I found the question altogether too hard for me. After a series of years our State laws were changed, giving us more and more protection, until at the present day I do not know that a sheep raiser can ask for any better laws, so far as compensation goes, than those in force in Connecticut. That, however, does not solve the difficulty. Dogs will come in the night and destroy half your flock. Twice I have struggled to get up a flock of a hundred breeding ewes, and upon two occasions I have had over one-half my flock killed in one night. The town paid me a reasonable compensation. But that is not the point. I have no fault to find with the compensation paid. The trouble is there is no inducement to try to raise a flock of sheep when that danger threatens us as it constantly does. I gave the business up in disgust some time ago.

Now where is the remedy? I do not know. I have never known a dog to kill sheep that was brought up with them. I have sometimes thought that if there was a tax of five dollars or more laid on each dog, that tax to be remitted to every one who would keep two or more sheep to bring up with the dogs, that it might be a remedy. I do not think it would be a hardship, for any man who can afford to keep a dog can afford to keep sheep. If I have been informed aright, in some European countries there are laws which allow every dog to be shot at sight which is trespassing. I think that might be one remedy. Another remedy may be the use of wire fences of sufficient height to keep the dogs out, but that I should throw aside as unavailable for I do not think that it is practicable. In raising sheep it is necessary to shift them sometimes from one field to another, and it would be necessary to

have such a fence around all fields in which such sheep were kept at any time. While it might be effective I do not think that it is a practical remedy.

Mr. STADTMUELLER. Mr. President, I should like to make a few remarks on this subject.

In the first place, I think there has been a wrong impression gotten by the present generation, that the decline of sheep husbandry in the State of Connecticut is, first and last, due to the ravages of dogs. That is only a secondary consideration. From the remarks of the gentleman who preceded me it can be seen that owing to certain things it was easier for him to obtain a livelihood in agriculture along other lines, and therefore he gave up the business of raising sheep. That has been the case with many, and that phase of the discussion is something which the speaker did not attempt to speak upon. The decline of the sheep industry is not alone due to dogs. It is not alone due to the change of fashion. It is also due to the relation which the sheep industry has borne to all of the other great commercial industries of the world all along the line. It has been due in part to conditions which have existed. We can now see a change in those conditions. The industry is coming in again. Sheep are on the ascendency. Under the old condition of affairs a farmer kept sheep for wool. Now the condition which confronts the farmer is to keep sheep for eating. The position of things is completely reversed. Wool is now a by-product, and the meat is the primary consideration. Forty years ago the conditions were exactly the reverse as was so clearly stated this afternoon. This is a period of transition. We are going from one thing to the other. Under this changed condition of affairs, I believe if my venerable friend Mr. Platts would start again in sheep husbandry he would find it profitable.

Now in regard to this dog question. Of course, there is this to be said about dogs, and it has been touched upon very lightly in this discussion, that is the lack of public sentiment

upon this question. One thing we need to do and that is to rouse public sentiment against the dogs and in favor of the keeping of sheep, and that is one thing that our Connecticut Sheep Breeders' Association is trying to do. That is one thing that every sheep breeder in Connecticut should stand for. We have pretty good dog laws. You look them over, and you will acknowledge, if you are fair and broad-minded, that it would be very hard to suggest any improvement in them. The trouble is that the dog laws which we have today are not enforced. Why are they not enforced? It is just because of the utter indifference of the agriculturists themselves. You cannot expect that those who have no interest in these matters in the State are going to enforce the dog laws. We sheep breeders cannot expect the dairymen to enforce them. The fruit growers are not going to enforce the dog laws. It is right up to us ourselves to see that they are enforced, and the only way to accomplish it is to arouse public sentiment upon this question and to go at it in the right way. I reside in the town of West Hartford. It is one of those towns that is perhaps equally divided between an urban and a suburban population. We have some sheep in that town. I was talking with our town clerk and asking about the dog tax. He said that up to three years ago the dog tax amounted to about eighty or a hundred dollars per annum. Our selectmen discovered that there was a statute upon the book which had been there for a great many years, reading something to this effect: that on or before the first day of June the town clerk of each town shall make a list of all the dogs which have been registered, etc., and it shall thereupon become the duty of the selectmen to find out if there are any dogs that have not been registered. Now how many towns are there in the State of Connecticut where that is applied? The statute is mandatory. It says that the selectmen shall do that. That is what they did in my town, and that is just what we want them to do in every town. We want some good live member of our association in

every town that will take it upon his shoulders to see that that statute is followed out and enforced. Mark the results in our town. Since that statute has been followed the dog tax has increased from eighty to a hundred dollars a year to over three hundred dollars per annum. It has increased the fund available for the proper remuneration and payment of damages done by dogs. It helps in another way. Many useless dogs will disappear in a town where that law is enforced.

Now just one word regarding the outlook. I presume many of you are subscribers or readers of the *Country Gentleman*, and if so, you have noticed the movement headed by Mr. Burr in western Massachusetts, for providing farmers with ewes, for loaning out ewes to the farmers. It is reported that that movement is meeting with unusual success. I do not know how many thousand ewes they have placed upon farms in western Massachusetts. They are loaned to the farmers upon the basis that the company will require every farmer receiving a loan of ewes to take care of them, and shall receive for his compensation fifty per cent. of the progeny and one pound of wool for each animal. If men can afford to take sheep on that basis and make a success of it, I do not believe there is a shadow of doubt but what they can go into sheep husbandry tomorrow, owning their own sheep, and make a good profit on the business. At first thought it seems surprising that such a proposition would be a success, and especially when carried out on a large scale where thousands of sheep are involved. Would you want to take a loan of ewes and guarantee to take care of the flock, to keep them and take all of the care of them for a year, and have for your compensation only fifty per cent. of the get and one pound of wool from each ewe? Still that is what that company up in Massachusetts is offering, and apparently making a success of. I will be much surprised if they do not offer it in Connecticut within a year or two.

Secretary BROWN. I invited the Secretary of the State Board of Agriculture of Vermont to be here this afternoon. He wrote me a very interesting letter, regretting exceedingly that he was unable to be present. He said that he was thoroughly interested in sheep culture, and he believed that nothing which he could think of promised so much success to our New England farms as to see them again covered with generous flocks of sheep.

Convention adjourned to 7.30 P.M.

EVENING SESSION.

Tuesday, December 12, 1905.

(Music.)

Convention called to order at 8 P.M., Vice-President Seeley in the chair.

The PRESIDENT. The hour has arrived for opening the meeting. While the men are arranging the stage for the main address of the evening we will have the question box for a few moments. The Secretary will please read what questions he has.

Secretary BROWN. Mr. President, I think we have two or three questions relating to sheep, but as Dr. Smead is not in the hall I will defer them until we can have the benefit of his expert testimony.

Now Mr. President, before taking up the regular programme, I would like to offer the following resolution:

"WHEREAS, there have been introduced into Congress House Resolutions 285 and 286, appropriating \$250,000 for suppressing the Gypsy and Brown-tail moths, and \$15,000 for procuring parasitic enemies of such moths, now therefore,

"RESOLVED, by this convention that our Senators and Representatives are hereby urged to use all honorable means to secure the passage of said resolutions.

"RESOLVED, further, that the Secretary of the State Board of Agriculture be directed to forward a copy of these

resolutions to each of our Senators and Representatives in Congress."

It is no secret, gentlemen, that the gypsy and brown-tail moth which have been so long a scourge in Massachusetts have already crossed the line into New Hampshire and into Rhode Island. A kind Providence has spared Connecticut from the ravages of these insects thus far. We do not know how long that intervention will continue. Any automobile or any railroad car coming out of the infected section is liable to bring them into this State. It has become more than a local question. It has become a question of national importance. The presence of these pests is a serious menace to our agricultural interests. The resolution introduced into Congress proposes that the national government shall take a hand in suppressing these pests, and this resolution is simply to represent the sentiment of this body of farmers assembled in convention. We are requested to urge our Senators and Representatives in Congress to use every effort in favor of the passage of these resolutions.

The PRESIDENT. Any one second the resolution?

A MEMBER. I second the motion, Mr. President.

The PRESIDENT. Are there any remarks?

Secretary BROWN. Mr. Chairman, Professor Wheeler of the Rhode Island Agricultural College is present. He is Secretary of the Federation of Agricultural Clubs in the State of Rhode Island, and has this matter in charge for that State. I would like to ask Professor Wheeler if he would say a word in regard to these resolutions.

PROFESSOR WHEELER.

Mr. President, ladies and gentlemen: I will say that the people in Rhode Island have been very much asleep on this gypsy moth question. I have been one of the worst of the sinners. Last season I went through some of the infected dis-

tricts. I had heard many things about the ravages of this insect, but I found a great many things far worse than any thing I had heard. These insects constitute one of the most serious pests that we have had to deal with. They even get into the houses and into the pantries. Conditions are so bad, and the pest is so numerous it is absolutely impossible to keep them out of the houses even where the greatest precautions are taken. It is one of the worst pests with which the American people have had to deal in the history of the country.

The female is unable to fly, and therein rests our hope of controlling them. Our federation in Rhode Island took up the matter, and we were of the opinion that the Government should come to our aid at the present time. The trouble has developed to such an extent that, in my opinion, it is beyond the ability of the states to successfully cope with it. We should have the aid of the national government. The insects have already spread into New Hampshire, and we have a local colony in Providence. It is reported that it is at the borders of Maine if not already in the State of Maine. Our federation has sent a circular to all of the New England State Boards of Agriculture, and I think they will be a unit in asking the government to appropriate money at this time to help control this pest. I wrote your Secretary about this, and found him very favorably inclined to bring this matter before you. I only wish to say further that whether you appreciate at present the necessity for your action or not you will in a very short time. I believe that the wisest course for Connecticut to pursue is to urge upon all of your Congressmen the necessity for using every effort to have this pest controlled. If it is not controlled, it is only a question of a very short time before they will spread into Connecticut and bring about here the havoc and ruin they have wrought in Massachusetts and other localities. It is a matter which must not be delayed. Every dollar which is spent now is better than ten later.

Mr. PLATTS. What have they done to exterminate it? What can they do?

Professor WHEELER. The State Board of Agriculture in Massachusetts expended some large sums of money, and they were on the point of exterminating the pest, but it is reported that the expenditure of the money got into politics, and the appropriation some years ago was cut off. As a result, the thing has become such a pest that the people can take no comfort in their homes. They destroy most everything in the way of vegetation. Even the evergreens are being destroyed, and whole orchards are being destroyed. Fruit trees and valuable shrubs. One gentleman that I know of has spent forty thousand dollars this last year in trying to control them upon his place, and is to spend seventy thousand dollars this year.

There are three things to do. First, to destroy the eggs close to the trunks of the trees. That is a work to be done now. If the work is to be undertaken so as to do much good, it ought to be undertaken now. Another thing, is to put a burlap around the trees and allow it to hang down three or four inches so that the caterpillars are unable to get up. Then they can be caught and crushed. The important work needs to be done before the leaves come out in the spring. An appropriation should be made by Congress, and, if possible, on the first day of January, or February, men should be at work. We should not lose a moment's time.

The PRESIDENT. You hear this resolution regarding the gypsy moth. All in favor say "Aye." It is passed.

The address on the programme for this evening is "The Story of Soils and Plants in Their Relation to Liming," by Professor H. J. Wheeler, Director of the Rhode Island Experiment station. The gentleman has just spoken to you about the gypsy moth. I have the pleasure of introducing him to you now.

THE STORY OF SOILS AND PLANTS IN THEIR RELATION TO LIMING.

BY H. J. WHEELER, Ph.D.,

Director of the Rhode Island Agricultural Experiment Station.

Mr. Chairman, Ladies and Gentlemen: It gives me much pleasure to greet a Connecticut audience. This pleasure is that of a former Massachusetts neighbor and as a neighbor and resident of Rhode Island.

Only those who have gone from another State with the plan of making Rhode Island the home of their adoption, can fully realize what it means to become a full fledged Rhode Islander. The two years of probation before one can cast a ballot inculcate a high appreciation of the blessings of true citizenship, and give ample opportunity for intelligent American-born citizens to arrive at a correct conclusion how to vote. Not being burdened at the outset with this duty of citizenship, my first two years in Rhode Island were devoted without interruption to becoming acquainted with her soils, the products of her farms, her people, and the agricultural problems to be solved. As a result of visits to every nook and corner of the State one could not fail to be struck with certain peculiarities which were markedly different from those that are to be observed in many other States and countries. An abundance of common sorrel, blackberry vines, certain varieties of St. John's wort, violets, five-fingers, and wild-grass were visible at every turn. The absence of a good stand of clover in freshly seeded mowing lands, the rapid disappearance of timothy, and the usurpation of its place by redtop and Rhode Island bent were most characteristic features.

Few of the soils are derived from the underlying rocks, but where they are, and whether from slate, pudding-stone, sandstone, conglomerate, or granite, the characteristics of the natural vegetation are much the same as those of the other areas where the soil is composed of granitic glacial débris.

While skirting the western borders of the State it happened occasionally that I inadvertently found myself in Connecticut, but neither the soil, the vegetation, nor even the people, gave a hint that the limits of the State had been overstepped. Perhaps it was the same recognition of the fact that there may be

considerable areas in Connecticut that are similar to most of the land in Rhode Island which led your Board of Agriculture to ask me to tell you something of our various liming experiments.

It is with a peculiar sense of vindication that I have accepted your invitation to present this particular subject, for the reason that many of my colleagues in New England were not ready to believe, ten years ago, that our upland well-drained soils were ever so acid and so greatly in need of lime that profitable yields of certain crops and the greatest returns from many of the commercial manures, were both impossible until after resort to liming. It was claimed that lime had been shown to be unnecessary in Massachusetts and that in all probability the need of lime in Rhode Island was confined merely to the farm of the Experiment Station or immediately surrounding areas. It is perhaps fortunate for the Rhode Island Station that there were so many doubters, since in consequence we had for several years a practically free field of investigation.

It may be of interest to state that in the early Massachusetts experiments to which reference has been made lime was applied in too small quantities per acre and Indian corn was employed in the tests; a crop which is frequently injured by liming.

Believing that it will be of greater interest to hear the actual story of our liming experiences than to listen to a pedagogically arranged lecture on the subject of lime and liming, an endeavor will be made to trace the investigations step by step.

It will be recalled that in the winter of 1889-90 Prof. Atwater, at that time Director of the Office of Experiment Stations in Washington, issued two plans in coöperative experiments. One of these embraced an ordinary soil test and also a test of the relative efficiency of nitrogen in dried blood, sulphate of ammonia, and nitrate of soda. Like amounts of nitrogen were employed in each instance for the "full rations." As a measure of control check plats were introduced. These, like those where the nitrogenous manures were applied, were all manured uniformly with muriate of potash, and dissolved bone-black. All of the nitrogenous manures were applied in "one-third," "two-third," and "full rations." The "one-third ration" of sulphate of ammonia amounted to 120 pounds,

the "two-thirds ration" to 240 pounds, and the "full ration" to 360 pounds per acre.

At the request of Ex-Director Flagg ten of these coöperative experiments were established in the spring of 1890, two being located in each county in the State. An additional acre was provided for upon the farm of the Experiment Station at Kingston. In the latter instance a positive ill effect of the sulphate of ammonia was noticed the first season. The extent of this injury is best indicated by the yields of stover. Instead of increased yields with each increase in the amount of the sulphate employed those produced with the "one-third," "two-third," and "full rations" were 3,000, 1,500, and 1,300 pounds per acre, respectively. The following year the corresponding yields were 1,840, 1,140, and 825 pounds per acre. By the use of dried blood and nitrate of soda in increasing amounts the tendencies to give increased crops was the general rule.

At Hope Valley injury from the sulphate of ammonia was visible the second and third years, and indications of approaching injury were soon observed in one or two other localities.

Upon looking up the records of similar injury or those concerning the inefficiency of sulphate of ammonia it was found that most of the European experiments with beets showed it to be far inferior to nitrate of soda as a source of nitrogen. With the cereals this was more rarely or less strikingly true. Two or three instances of the bad effect of sulphate of ammonia had been cited by French and German writers but no one seemed to be at all sure of the cause, nor had there been shown to be a positive remedy.

In speculating concerning the probable reason for the trouble in Rhode Island it was recognized at once that the soil was derived from granitic rock and that in view of the character of the minerals of which it is composed lime might be deficient. It was also already a matter of record that the granitic soils of Scotland need lime. The same was known to be true of certain of the sandy soils of northern Germany. It had also been recorded by several French writers that successful agriculture in certain Departments in France was impossible without resort to liming, especially where the soil was of granitic or of sandstone origin. Especial emphasis had been laid by these writers upon the conditions in the Department of Limousin. There the soil was derived from granitic

rock and the agricultural conditions were miserable in an extreme degree until the construction of a railroad rendered it possible to introduce lime at a reasonable cost.

Several of these European writers referred to the soils as positively acid.

In view of the knowledge of these conditions in other countries it seemed probable that the difficulty in Rhode Island was due either to soil acidity and a lack of sufficient carbonate of lime in the soil, or to the absence of the organisms which are capable of changing the ammonia into nitric acid.

The first step actually taken was to test the soil for acidity or a lack of carbonate of lime, by means of several different chemical methods. Of these the blue litmus paper test was found to be the most trustworthy of the simple tests.

HOW TO MAKE THE TEST WITH BLUE LITMUS PAPER FOR ASCERTAINING THE NEED OF LIME IN SOILS.

Concerning the test, the best plan for farmers to pursue is to have the soil tested if possible by the Experiment Station Chemist, for familiarity with the method enables one to arrive at a more correct judgment concerning the probable lime requirement. Still other and more elaborate tests can also be made in the laboratory.

In making the blue litmus paper tests the soil is first moistened until it is of about the consistency of a thick porridge. It is then parted, a strip of blue litmus paper (two inches long by half an inch wide) inserted and the soil pressed around it. After an hour or two the paper can be removed and rinsed by dipping in water a little less deeply than it was inserted in the soil. The end introduced into the soil should not be touched with the fingers. If this latter precaution is taken and it is found upon removal that the paper has entirely lost its blue tint and an intense pinkish red or brick red color has taken its place, it is probable that the soil needs liming.

FURTHER EXPERIMENTS WITH THE KINGSTON SOIL.

The soil where the sulphate of ammonia proved injurious turned a blue litmus paper rapidly red. It was tested to ascertain if proto-sulphate of iron, an occasional toxic constitu-

ent of soils, was present, but the tests revealed none. In order to correct the acid condition of the soil and to insure the right conditions for the nitrification of the ammonia, it was decided that it would be best to lime a portion of all three of the plats which received sulphate of ammonia and to sow some garden soil upon one-half of each of the limed sections, the garden soil to be immediately mixed with the other by cultivating. The idea of introducing the garden soil was to make sure of the presence of the nitrifying organisms.

Owing to doubt as to the probable success of the experiment on the part of those in authority, it was not until late in the season of 1891 that permission to undertake it was obtained. It was then too late to introduce either the lime or the garden soil into the soil of the field in a thorough manner without injuring or destroying the crop of Indian corn already upon the land. For this reason only slight indications of benefit from liming were observed the first season.

During the following winter it was shown by Müntz, a French investigator, that the nitrifying organisms are practically present everywhere, even under the glaciers of the Alps and in the interstices of the rock masses of the Faulhorn. For this reason it was not deemed necessary to try further inoculations with garden soil especially since proto-sulphate of iron, which was said to be poisonous to these organisms, had been shown not to be present. In the spring of 1892 a further application of lime was made to the same sections of the three plats which had been limed in 1891. Indian corn was again planted. As soon as the corn was a foot or more in height it was evident that a wonderful change had taken place, for now the growth was better upon the limed areas, with each increase of sulphate of ammonia. Upon the unlimed sections of the plats the results continued to be poorer with each increase.

The view upon the screen shows in the center three rows of corn of the crop of 1893 where the "two-thirds" ration of sulphate of ammonia was used. The much better corn in the background stood upon the limed sections of the plat.

A nearer view of the corn where the lime was used shows the benefit from liming in a more striking manner.

The better growth with the full ration of sulphate of ammonia, after liming, stands in striking contrast to the poorer growth with the same ration before lime was applied.

Here are seen two lots of corn at the left which were grown at Hope Valley, Rhode Island, by the use of a "full ration" of nitrate of soda. The lot at the extreme left grew upon the limed section of the plat and the one at its right grew upon the unlimed section. Little difference in the two is noticeable. Nitrate of soda is, therefore, an immediately efficient nitrogenous manure for soils that lack carbonate of lime and by its continued use the conditions often improve rather than grow worse. In this respect it differs wholly from sulphate of ammonia. The two lots of corn shown at the right, were grown where a "full ration" of sulphate of ammonia had been applied. The large lot at the left was from the limed area of the plat and the small one at the right was from the section where no lime had been used.

At the same time that these and other experiments were in progress in Rhode Island, Wagner and Dorsch in Germany experimented with summer rape grown upon a muck soil by the use of sulphate of ammonia. It was found that when used without carbonate of lime its effect was equal to 28 per cent. of the effect of the same amount of nitrogen in nitrate of soda but that after liming it rose to 90 per cent.

In connection with the publication of this experimental work in Rhode Island, attention was called to the falling off in yields with the ammonium salts as compared with the results with nitrate of soda, at both Rothemstead and Woburn, England. In fact it was shown at the Rhode Island Station in 1893 that the cereals were affected in a very unlike degree by the conditions which cause the ill effect of the sulphate of ammonia. For example, Indian corn and rye withstood the conditions best, then oats, wheat, and finally barley. In this connection it is of interest to note that in 1897 J. A. Voelcker, chemist to the Royal Agricultural Society of England, called attention to the greater falling off of barley than of wheat in experiments with a mixture of ammonium sulphate and ammonium chloride at Woburn. He attributed it at that time to ability on the part of wheat to send its roots deeper and to appropriate lime which the barley roots could not reach. Not until 1901 did Voelcker test his soil with blue litmus paper, when it was found to give an acid reaction. In 1902 he reached the conclusion that the differences in barley and wheat, which were observed earlier, were really attributable to a differ-

ence in the power of the two cereals to resist acidity. Later experiments showed, in full agreement with those in Rhode Island, that oats could resist the conditions much better than either wheat or barley.

The two plats now shown were embraced in the Woburn experiment with the ammonium salts. The plat at the right, where little barley is to be seen, had not been limed, while that at the left, where there is a fine crop, received two tons of lime per acre, about three years before this view was taken. It will be seen that the lime has fully corrected the ill effect of the ammonium salts.

Where certain mineral manures were used with the ammonium salts the injury from the latter was longer delayed and was slightly less serious than when it was used alone. Here also the addition of lime corrected the condition.

Recently A. D. Hall, Director of the Rothamstead Station, mentioned the bad influence of the continual use of the two ammonium salts which have just been mentioned, and says that sorrel became abundant upon the plats which received them, excepting where carbonate of lime had been applied.

A more striking illustration could hardly be afforded of the influence of soil conditions upon the relative amounts of sorrel and clover than that afforded by the plats in the nitrogen experiment at the Rhode Island Station. Where mineral manures only were used there was no clover upon the unlimed sections of the plats, but common sorrel was abundant. Where lime was applied there was a full, splendid stand of clover, with but traces of sorrel. The amount of the common sorrel was less upon the unlimed plat where nitrate of soda had been used than upon the corresponding plat receiving dried blood. By the use of sulphate of ammonia, without lime, the amount of sorrel was three and one-half times as great as with dried blood used under the same conditions. In fact it fully occupied the ground to the utter exclusion of clover and it was nearly knee high. A more magnificent growth of sorrel than was observed in that instance is hardly conceivable.

A SPECIAL STUDY OF THE INFLUENCE OF LIMING UPON DIFFERENT VARIETIES OF PLANTS.

In 1893 four adjacent plats of land of exceptionally uniform character were secured for more extended experiments with lime. Observations were already on record concerning the natural herbage of calcareous and other soils, and also many miscellaneous observations as to the effect of lime upon the growth of a few varieties of agricultural plants. It was, for example, well understood that lupines are usually injured by liming and that clover is helped by it. Nevertheless no one had ever taken up the study in a continuous and systematic manner, and so far as concerned the vast majority of agricultural plants little or nothing was known concerning the influence of lime or of soil acidity upon their growth. In order to study this matter experiments, which are still in progress, were begun in 1893 upon four plats of land, separated by three-foot paths. The plats have all been manured alike with magnesium sulphate (Epsom salts), dissolved bone-black (or acid phosphate), and muriate of potash, from the beginning of the experiment to date. Two of the plats received their nitrogen in nitrate of soda and two in sulphate of ammonia. The absolute amount of nitrogen used upon each plat is nevertheless kept identical. One of each of these pairs of plats was limed in 1893 and 1894 and again recently.

The central path shown in this view passes between the two plats which receive sulphate of ammonia. The unlimed plat is at the right. It may be seen in the background that some varieties of plants are making a good growth even upon this plat. The two plats which receive nitrate of soda are indistinctly or partially seen at the left.

In this view are shown the two plats manured with nitrate of soda, the unlimed one being at the right. Here also the marked effect of liming upon certain varieties of plants is noticeable.

With the exception of one or two years a large number of varieties of plants have been grown in rows annually across the four plats.

The plat receiving nitrate of soda and lime is now slightly alkaline to litmus paper. In other words it now turns red litmus paper blue instead of turning a blue litmus paper red,

as it did originally. The plat receiving sulphate of ammonia and lime is still slightly acid in its reaction upon blue litmus paper. The plat receiving nitrate of soda but no lime is still more acid, and the one receiving sulphate of ammonia but no lime, reacts far more intensely acid than at the outset. At the time when the varieties of plants were grown which are to be shown upon the screen, even the limed plat, which received nitrate of soda, was still very slightly acid as shown by blue litmus paper, and the others differed from it only in the degree of acidity.

The two apple trees at the left grew where sulphate of ammonia had been applied, and the two at the right upon plats receiving nitrate of soda. The better growth at the right of each pair shows that liming was helpful. The tests unfortunately could not be continued to the time of fruiting, and hence they throw no light upon the yield and the quality of the fruit as affected by liming.

It will be observed that in both instances the Norway spruce trees exhibit injury from liming. The same susceptibility to injury by liming is said to be true of the chestnut, azalia, rhododendron, and of certain other members of the family to which the two latter plants belong.

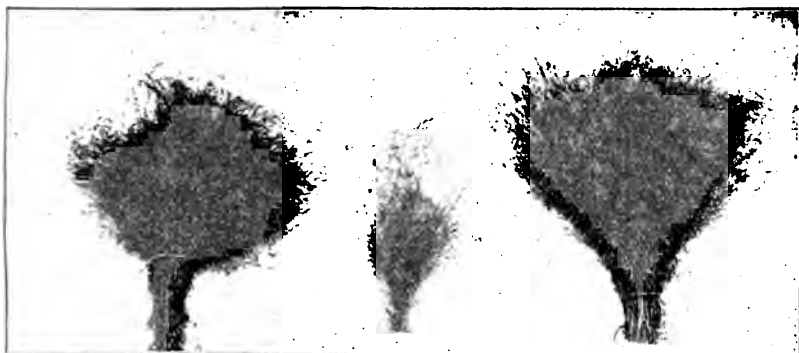
The white birch has shown marked adaptability to acid unlimed soils, but it seems less likely to be injured by liming than the spruce, cranberry, and certain other trees and herbaceous plants that might be named.

The quince bushes show a marked beneficial influence of the lime. A similar though somewhat less striking benefit from liming was observed with cherries and the American linden.



The two lots of cranberry vines at the left grew upon the plats receiving sulphate of ammonia, and it is of much interest

to note that the best growth of vines, shown at the extreme left, occurred upon the unlimed plat, where clover, lettuce, spinach, cantaloupes, onions, and asparagus usually die outright. It will be seen that the vines at the extreme right from the limed plat, receiving nitrate of soda, were inferior to those at their left, where lime was omitted.



The reason for showing but three lots of asparagus is that during the first and second years all of the plants died upon the unlimed plat which received sulphate of ammonia. The lot at the left represents the result where lime was used with the sulphate of ammonia, and the one at the extreme right shows the results with lime and nitrate of soda. In this instance the great advantage of liming is shown even where nitrate of soda was used, as seen by comparing the two lots at the right.

Below are given the relative weights of marketable asparagus obtained in the year 1900.

Plate No.	Pounds of asparagus
23, unlimed, sulphate of ammonia . . .	0.00
25, limed, " " " . . .	5.87
27, unlimed, nitrate of soda . . .	1.01
29, limed, " " " . . .	9.62

From this it will be seen that liming increased the crop over nine times even when nitrate of soda was employed.

The pumpkins show a positive beneficial influence of lime. It is hoped that these observations may aid the residents of New England to continue to place before their Thanksgiving guests the time-honored "open-faced" pumpkin pie.

Serradella, which is sown with spring grains in Germany, to serve later in the season as a sheep feed, and later as a soil renovator, thrives well upon very acid soil, in which respect it differs widely from most, if not all, of the clovers, the san-foin, lentil, vetch, pea, and certain other legumes. The two lots at the left, grown by the aid of sulphate of ammonia, were apparently as good as the other two, grown with nitrate of soda. In fact, liming heavily just before the crop is grown, though helpful to clover, is injurious to serradella.

The soy bean and southern cow pea are two other legumes which should follow in the rotation, preferably three or more years after liming, though the soy bean seems to need the long interval less than the cow pea.

The onion does not thrive upon a very acid soil, a fact in full accord with the general idea that wood ashes, which contain over 30 per cent. of lime, make a good manure for this crop. Where sulphate of ammonia was used on the unlimed soil only two or three small onions resulted. In the case of the two lots at the right, from the limed and unlimed plats which received nitrate of soda, the yield without lime was 24 pounds and with lime, 44.3 pounds. These results throw satisfactory light upon the former inability of certain farmers in Massachusetts to grow onions, especially where brands of commercial fertilizers had been used which were acid instead of basic in character.

In the case of the flax the products of the limed plats show little increase from liming. Flax is, therefore, well adapted to acid soil.

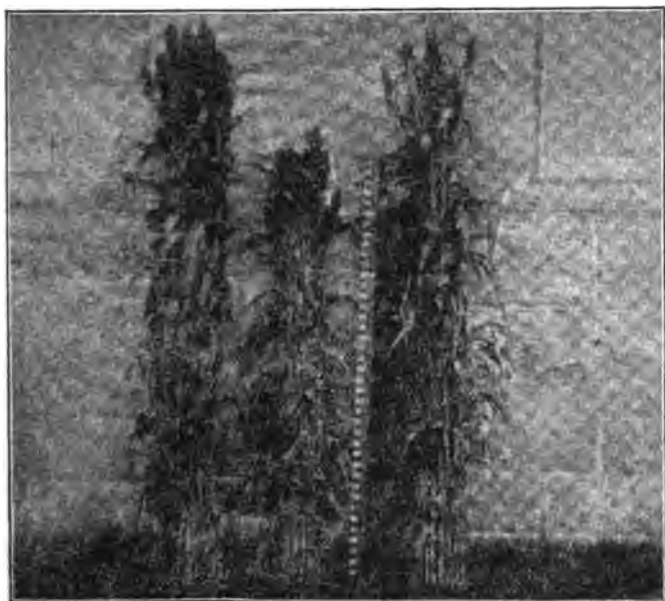
In the case of the chicory little difference in yields resulted; it is evident that chicory will thrive well even upon very acid unlimed soil.

In the case of the broom corn the results with sulphate of ammonia are shown at the left. The second lot from the left and the one at the extreme right were from the limed plats. Broom corn is, therefore, helped by lime.

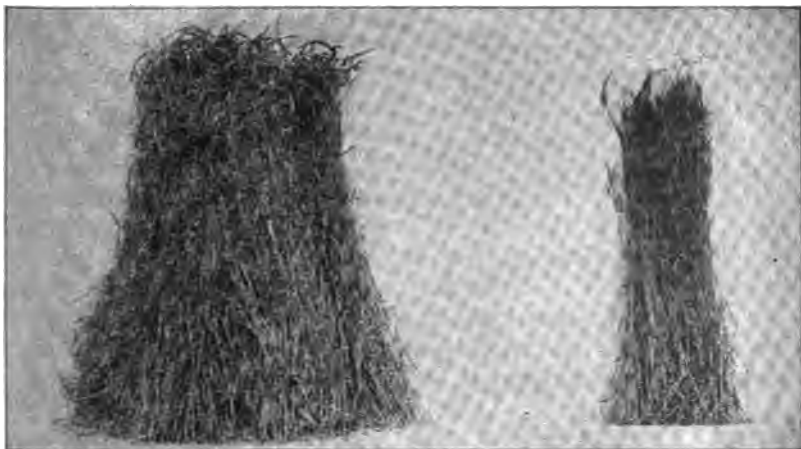
The carnation pink can thrive upon quite acid soil. Liming was nevertheless beneficial in both instances.

Crimson clover can thrive fairly well upon soil which shows considerable acidity, yet upon very acid land liming proved absolutely essential to its success. The two large piles are from the two limed plats. Upon the unlimed plat receiving sulphate of ammonia, it practically failed.

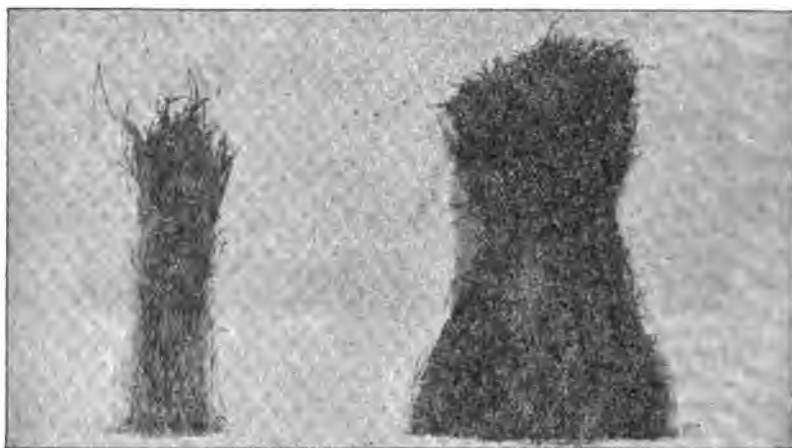
These two bundles of grass are from the limed plat which receives sulphate of ammonia. The grass was assorted, the



large bundle of timothy being shown at the left and the small lot of redtop at the right. This should be compared with the next view.



In this view the results are shown where sulphate of ammonia was used upon the unlimed soil. The small amount of timothy is shown at the left, and the relatively large amount of redtop at the right. The foregoing results taken together with these show the wonderful ability of redtop to thrive upon acid soils, and also the fact that such soils will not support timothy until after liming. What has been said concerning the need of lime for timothy is likewise true of Kentucky blue grass and in a less degree of the awnless brome and other grasses. Rhode Island bent grass, which is closely related to redtop, exhibits the same remarkable ability to thrive upon very acid soil. The very fact of the existence of splendid fields of this



variety of bent grass in the State of Rhode Island is indicative of soil acidity, and the need of lime. It is a case of the "survival of the fittest" upon the acid soil.

In view of the fact that the conditions favorable to timothy are also favorable to Kentucky blue grass care should be taken where timothy and redtop are both desired to secure seed free from the seed of Kentucky blue grass or it will tend to crowd out both the timothy and redtop, producing essentially a "turf-bound" condition.

Alfalfa, like winter vetch, seems to thrive best after using enough lime to render the soil slightly alkaline. In marked contrast to lettuce, spinach, beets, the best results with alfalfa

have usually been obtained upon the limed plat manured with sulphate of ammonia instead upon the other limed plat.



The results with cabbages grown with the aid of nitrate of soda are at the left, and they show its superiority to sulphate of ammonia. Liming proved helpful in both cases as shown by the larger piles.



The watermelon seems to be quite at home upon acid soil. The product with nitrate of soda is at the left, and with sulphate of ammonia at the right. The smaller yields in both cases were upon the limed plats. It is remarkable that the watermelon should be injured by liming, and that it should thrive splendidly upon the unlimed plat receiving sulphate of ammonia, where upland cress, Kaffir corn, sorghum, barley, the cantaloupe, and many other varieties of plants utterly fail.



The cantaloupe is the opposite of the watermelon! The crop from the plats receiving sulphate of ammonia were always inferior to the corresponding ones manured with nitrate of soda. In each case the limed plats produced the larger product. In fact it was seldom, if ever, that fully ripened

fruit was obtained upon even the unlimed plat where nitrate of soda was used.



The crops of German millet produced by the aid of nitrate of soda are at the left. It will be seen that the result upon the limed plat, shown at the extreme left, was not as good as where lime was omitted. In the case where sulphate of ammonia



was applied, liming proved helpful. Though unable to endure the degree of acidity which is favorable to the watermelon,

German millet seems to thrive best upon moderately acid soil, and liming to the limit of producing alkalinity or even less, is injurious to it.

The following five views show the results with rye, oats, wheat, barley, and sorghum. The products obtained by the use of nitrate of soda are arranged in each instance on the left. The absence of a fourth lot of sorghum at the right was due to its total destruction on the most acid soil. The lot at the extreme left and the second one from the right in each case shows the product from the respective limed plats. It will be seen that the rye and oats endure the acid conditions best and that the sorghum is helped most by liming. Barley needs lime more than wheat and the latter more than oats.

The two lots of tobacco at the left were grown with nitrate of soda, and the two at the right with sulphate of ammonia. The larger lot at the left of each pair was from the respective limed plat. Liming improved the color of the ash in a most remarkable degree.

This view shows that amber cane (sorghum) and Kaffir corn refused to grow upon the unlimed plat, manured with sulphate of ammonia, notwithstanding that the seed germinated well.

This shows the wonderful benefit which resulted to these plants solely from liming. These plants, like the upland cress, onion, cantaloupe, poppy, lettuce, spinach, and beet, are unable to endure a great degree of soil acidity, and the accompanying lack of carbonate of lime.

The limits of such a lecture preclude showing all of the results obtained with about 200 different varieties of plants. Among the beans and also among the annual flowering plants that have been tested, the most remarkable differences have been observed. These results show that the poppy can never become a pernicious weed upon our acid soils, as it has in the wheat fields of the limestone regions of Europe. The castor bean is injured by liming where the golden wax, a string bean, will almost fail for need of liming. The bush lima bean in contrast to certain of the bush green-podded string beans thrives well upon very acid soil.

CONCERNING THE GENERAL NEED OF LIME IN RHODE ISLAND.

Having begun the experiments just enumerated, it became important to learn if the need of lime was more or less common in all of the five counties of the State, and in order to test the matter, coöperative experiments were begun in many different sections. Two plats were manured alike with standard agricultural chemicals. One of these was then limed and beets, barley, grass, and clover were employed in the various tests.

At Foster Center, R. I., in 1896, the yields of red table beets upon the limed and unlimed plats were 143.4 and 36.6 pounds respectively.



In a similar test at Slocums, the yield of table beets upon the unlimed plat was but 1 pound and upon the limed plat it was 101.8 pounds. The barley (cut in the milk) was increased in this case by liming from 3.7 to 39.1 pounds.

In 1897 clover was grown upon the plats at Foster Center. The first crop, upon the unlimed plat, amounted to 140.2 pounds, and upon the limed plat to 195.6 pounds.

In a grass experiment at Hamilton, a section of the unlimed plat gave a product of 151.6 pounds, consisting of about equal parts of timothy and redtop. A corresponding section of the

limed plat yielded 205.1 pounds, consisting chiefly of timothy associated with some redtop.

The clover section of the limed plat at Hamilton yielded 204.6 pounds, consisting of about equal parts of clover and redtop, mixed with a few other grasses. The yield of the unlimed section, shown at the right, was but 66.9 pounds; only 8.8 pounds of which consisted of clover.



The second crops of clover from the limed and unlimed sections at Hamilton weighed 74.4 pounds and 0.1 pounds respectively. The smaller amount was cut with a pocket knife, and placed in a straw hat in order to make it visible.



This experiment was conducted upon the hill land at Kingston.

The crops from the two clover sections of the plots were harvested and the clover was separated from the weeds. The two lots at the left represent the clover and weeds from the

limed section, the clover being at the extreme left. The two piles at the right are from the unlimed section, the one on the extreme right being the weeds. Where lime was used, the crop was chiefly clover, but upon the unlimed land the weeds weighed nearly as much as the clover.



At Moosup Valley the yield of Mangel Wurzel upon the unlimed land was at the rate of but three tons per acre, but where lime was used it amounted to twenty and three-fourths tons per acre. The view shows the exact relation of the two crops. The lot representing the unlimed area is seen at the right. This was pasture land where chemical manures had possibly never been used.

These and many other similar experiments conducted in different parts of Rhode Island were sufficient to convince the most skeptical that the need of lime was more or less general in every portion of the State.

INFLUENCE OF LIMING UPON THE POTATO SCAB.

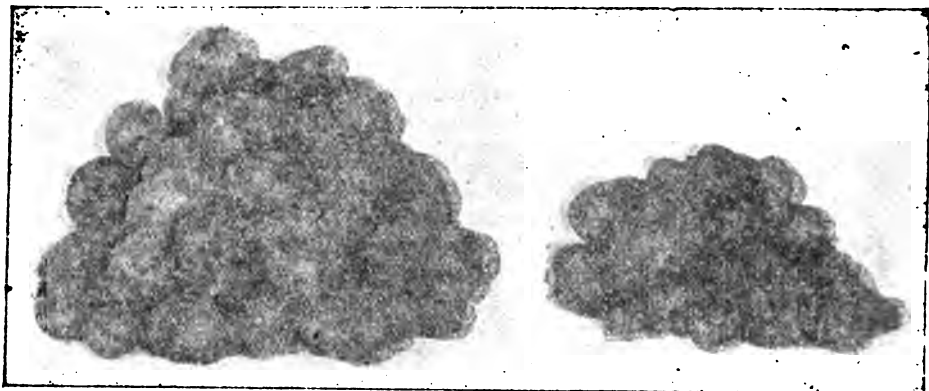
While digging the potatoes grown in the previously mentioned series of experiments upon the four plats, it was noticed that those grown upon the limed plats were badly scabbed while the others were not. Professor Thaxter at your own Station in New Haven had shown previously that the scab was due to a fungus which grows upon the surface of the tubers. He had also experimented in a limited way concerning the effect of various substances in promoting scab. These latter experiments were brief and necessarily inconclusive, since, for example, it was noticed that plaster and cement exerted "a

very decided influence especially upon the virulence of the disease," but that wood ashes "had no apparent connection" with it. No explanation for the action of the mortar and cement was offered and it was even looked upon as possibly incidental.

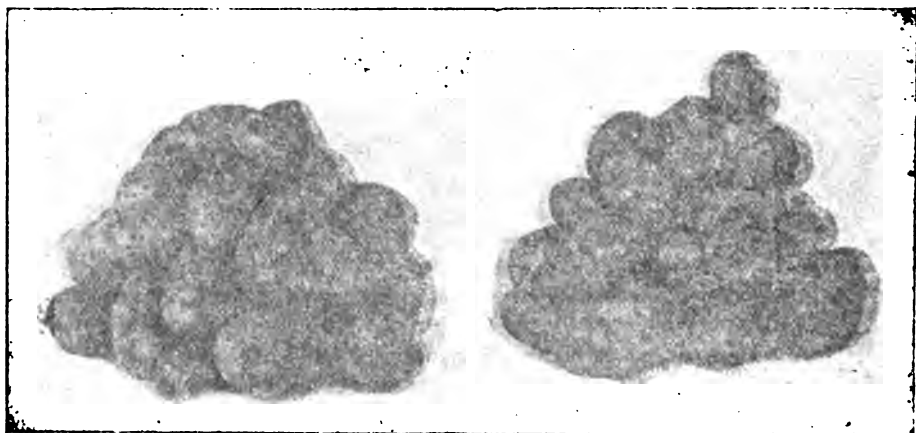
Professor Thaxter found in his pure cultures of the fungus that it grew best in a neutral medium, and this report suggested the idea that if the soil were alkaline the fungus might be aided by it in overcoming the acidity of the tuber while growing upon its surface. If on the contrary the soil were acid it seemed reasonable that it would be more difficult for the fungus to vegetate upon the tuber which the soil surrounded. With these ideas as a starting point the question was studied exhaustively for four years. In brief it was found that stable manure did promote potato scab provided the fungus was present; that the addition of common salt or of acid to the manure lessened the tendency, and that the addition of an alkaline substance, such as sodium carbonate, made the conditions still worse. Slacked lime, wood ashes, carbonate of lime, and substances such as calcium acetate and calcium oxalate which yield calcium carbonate quickly in the soil; or in other words alkaline substances or other compounds which change into such readily, favored without exception the development of scab upon the tubers. On the contrary sulphate of lime (land plaster) and calcium chloride, two compounds that under ordinary circumstances can neither increase the alkaline reaction of the soil nor practically lessen its acidity, both failed to increase the scab. In short the experiments seemed to establish beyond a doubt that even if the scab fungus is present, no considerable amount of scab will develop in a very acid soil if care is taken to avoid alkaline manures. On the contrary if the fungus is already in the soil or if it is introduced into it upon the tubers used for planting, and alkaline manures are used, the crops may after one or two years be practically ruined by the scab.

In the view presented here, the product of potato tubers obtained where air-slacked lime had been used is to be seen at the left; the lot at the right, grown also with the aid of chemical manures but without lime, was entirely free from scab even though badly scabbed tubers were planted in each case.

The left hand lot in the present instance received calcium sulphate, in addition to the same chemical manures which were used in all of the other cases. The lot at the right was grown with the aid of calcium chloride. In the former case but 4.3 per cent. of the tubers were scabbed and in the latter case none of them were affected.



This view shows the results with carbonate of lime at the left, and with calcium oxalate at the right. In the former case 97.5 per cent. of the tubers were badly scabbed and in the latter case all of them were totally unfit for market, on account of scab.



In this final view of potatoes the results with calcium acetate are at the left and those with unleached wood ashes are at the right. In both lots every tuber was scabbed and in the former case 97.5 per cent. of the lot was rendered unfit for market. In the case where the wood ashes were used the yield was good but not a single smooth marketable tuber resulted.

In the light of these results the question which naturally suggests itself is: Why did not Professor Thaxter find that wood ashes favor scab in the same manner as the mortar and cement? The answer seems to be that either the tubers which were planted where wood ashes were used were free from the fungus, as well as the soil itself, or else Professor Thaxter in his zeal used more wood ashes than would be likely to be employed per acre in agricultural practice, thus rendering the soil about the tubers so alkaline that the fungus could not grow. This seems probable for the reason that the mortar and cement would render the soil less alkaline than the same weight of wood ashes, and possibly on this account they produced a condition which was especially favorable to the development of the scab fungus.

Too great alkalinity like too great acidity should lessen the scab judging by Professor Thaxter's experiments upon the pure cultures of the fungus.

The practical suggestions growing out of the Rhode Island experiments are the following:

First. Avoid using scabbed tubers in planting, if possible.

Second. If scabbed tubers or such as are not positively known to be free from the fungus are used, wash them thoroughly with water and then treat them with corrosive sublimate solution or with fresh formalin, as recommended by Bolley and others. (For directions see Farmers' Bulletin No. 77, U. S. Department of Agriculture.)

Third. Avoid as direct manures for the potato crop wood ashes, lime, stable manures, basic slag meal, carbonate of potash and any and all other substances which are alkaline in their reaction.

Fourth. If for other reasons these alkaline substances should be added to the soil, apply them from two to four years before potatoes are to be grown and always treat the "seed" tubers as recommended under (2). In this way the Rhode Island Station has for more than ten years avoided scab

and at the same time enjoyed in a considerable degree the beneficial influence of liming in increasing the yield of tubers of merchantable size. By taking these various precautions at the suggestion of the Rhode Island Station, a lady farmer in the State reports this year a smooth crop for the first time in several years.

Fifth. If the soil is already badly contaminated with the scab fungus no treatment of the tubers will insure a smooth crop.

Sixth. If the soil is contaminated, rolling of the "seed" tubers in flowers of sulphur and scattering sulphur upon the seed tubers in the drill, as first suggested by Halstead of New Jersey, will lessen the scab. This is, however, an expensive treatment. At the Rhode Island Station sulphate of ammonia (ammonium chloride would doubtless accomplish the same result), muriate of potash, and acid phosphate applied in the drill have been found effective in lessening the scab in soils already contaminated. These materials also serve a manurial purpose at the same time.

THE INFLUENCE OF LIMING UPON THE "FINGER-AND-TOE" OR "CLUB-FOOT" DISEASE OF TURNIPS AND OTHER PLANTS.

It has been found by investigators in England, and later in the United States, that liming counteracts to some extent the tendency to "finger-and-toe" or "club-foot" disease in the turnip, cabbage, and other closely related plants. J. A. Voelcker of England tested the effect of gas-lime and slacked lime as compared with no treatment. As a result it was found that the least "finger-and-toe" disease resulted where the slacked lime was used.

WHEN TO APPLY LIME.

In order to answer the flood of questions coming to the Rhode Island Station concerning the best time to apply lime, especially for grass lands, three plats were prepared in the late summer. All three were manured in an identical manner. To one plat slacked lime was applied at once and thoroughly harrowed into the soil. The same amount of lime from the same lot was set aside until the following spring, when it was applied to the surface of the second plat as a top-dressing.

The third plat received no lime. All three of the plats were seeded to timothy in the early autumn in an identical manner.

At the right, where the lime was worked into the soil before seeding, the stand of timothy was good. Only a very small stand of timothy was secured where the lime was used as a top-dressing. Where lime was omitted altogether timothy was wholly absent. In all but the first instance the product was chiefly weeds mixed with a small amount of such grasses as could thrive upon acid soil. The material from the top-dressed plat is shown in the middle and that from the unlimed plat at the left.

THE INFLUENCE OF LIMING UPON THE HUMUS.

It was found, after a lapse of several years, that under continuous culture with hoed crops the amount of humus in the soil became somewhat reduced upon the limed plats. At the same time the percentage of nitrogen contained in the humus became greater. It might be inferred, therefore, from the investigations conducted by Hilgard that on this account the efficiency of the nitrogen in the humus may have been increased. Under a system of cropping, which includes the occasional turning under of a grass sod, there need be no fear of injury to the soil from a depletion of the humus by liming, so long as proper attention is paid to the kind of soil and the amount and kind of lime applied. To illustrate, a sandy soil should seldom, if ever, receive more than from half a ton to one ton of lime per acre at a single application, and for such soils the carbonate of lime is usually preferable to either slacked or plain burned lime.

In this connection a word ought to be said about "humus" in a general way. Some of the dictionaries define humus as essentially a brown substance produced by the action of the air upon vegetable and animal matter. Many writers also refer to the entire mass of the organic matter in soils as "humus." Grandeau applied the name *Matière noire* (black matter) to that part of the organic matter which could be extracted from the soil by means of ammonia water after the preliminary removal of the lime and magnesia. Much is said in the agricultural press about the need of humus in the soil, yet usually without reference to whether the term humus as used applies

to the black matter mentioned by Grandeau, or to the total organic matter.

It is a fact that some of the most fertile soils in the United States have neither a large amount of "black matter" nor of total organic matter. The soil of the Experiment Station farm in Rhode Island was found to contain from $3\frac{1}{2}$ to $3\frac{3}{4}$ per cent. of "black matter" or far more than many of the fertile soils referred to above. In addition a considerable amount of less fully decomposed organic matter was also present. Here one would suppose there must surely be an abundant supply of "humus," but yet as a matter of fact so large an amount of the very fine "black matter" is present that it seems to injure rather than benefit the physical character of the soil. Notwithstanding the large amount of "humus," as the term is ordinarily used, the further introduction of vegetable matter, either undecomposed or in the first stages of decomposition, seems to improve the condition of the soil greatly for certain varieties of plants. Such matter is in condition to lighten the soil and improve its tilth, but if already in the stage of the "black matter" as described by Grandeau, the same result could not be expected.

WHY WAS LIME BENEFICIAL TO THE RHODE ISLAND SOILS?

The question which arose early in the history of the lime investigations in Rhode Island was: How is lime beneficial? If it was helpful solely as plant food then this deficiency could only be revealed by field tests with plants or by complicated laboratory methods. If lime was needed because the soils of Rhode Island were acid, then the simple test with blue litmus paper was likely to reveal the need. This is a test which it is possible for every farmer to make. It is also one by which hundreds of soils can be tested in Station laboratories in a short time at small expense. If lime were needed solely for physical reasons it seemed possible that land plaster or other lime compounds might prove equally or more efficient. At all events the importance of answering why lime was needed must be obvious to all.

If lime helped by virtue of correcting an acid condition of the soil it was to be expected that similar benefit would result from the use of still other substances that could neutralize

acids. To test this point lettuce was planted in four pots eighteen inches in diameter. All of the four pots were manured alike. Two of the pots received no further treatment and in the absence of crops from these pots stones were substituted for them when the photograph was taken. The third lot from the right was grown where an additional "half-ration" of sodium carbonate was used, and the better lot at the left where the "full ration" of sodium carbonate was employed. The wonderful benefit derived from its use showed that here was another alkaline substance, containing no lime, which was exceedingly helpful.

If slacked lime proved useful only as a plant food and in flocculating and thus improving the physical condition of the soil, then it was to be expected (judging from experiments by others) that sulphate of lime (land plaster) might be equally as effective, provided an equal amount of lime in each combination were employed. It will be remembered that the lime in sulphate of lime is already combined with a strong mineral acid, oil of vitriol, and hence it cannot correct acid conditions without first undergoing a change into carbonate of lime in the soil. This change is so slow that it has little immediate practical significance in ordinary well-drained upland soils.

The largest two piles of beets were produced by the aid of air-slacked lime and the next largest pair with sulphate of lime. The results were still poorer in the case of the other two plats where neither lime compound was used. Mention should be made of the fact that in all of the cases a liberal manuring with potash, phosphoric acid, and nitrogen had been provided. It will be seen that the land plaster failed to accomplish the same result as the slacked lime.

Without going further into the details of the investigations in this direction, which covered in all a period of three to four years, it suffices to say that potassium, sodium, and magnesium compounds which were capable of neutralizing acidity were all more helpful to the soil than other compounds of the same elements which could not aid in the same way. It was, therefore, concluded that the need of the soil was primarily alkaline substances and that, therefore, the blue litmus paper test furnished a probably reliable guide as to its liming requirements. If this is true it is obvious that this or some equally or more efficient test for acidity should be more generally applied to soils.

IN MAKING THE TEST IS IT NECESSARY TO WAIT UNTIL THE
LITMUS PAPER DRIES BEFORE DRAWING CONCLUSIONS AS
TO THE PROBABLE NEED OF LIME?

When the litmus paper was first put into use for testing soils at the Rhode Island Station a statement was found on record by one of the German authorities that the paper must be dried before definite conclusions can be drawn as to the need of lime. It would be but natural for a farmer to do the drying in the sunlight, the action of which is to bleach the paper to such an extent as to interfere in drawing conclusions as to the probable effect upon it of the soil. The drying also meant some extra delay and trouble. A careful investigation of the question was, therefore, undertaken in the laboratory, which showed that it was not necessary to wait for the paper to dry before drawing conclusions as to the probable necessity for liming. An explanation of these details is unnecessary here and it would be of interest only to chemists.

THE INFLUENCE OF LIMING UPON THE PHOSPHORUS COMPOUNDS
OF THE SOIL AND UPON CERTAIN PHOSPHATES USED AS MANURES.

In the course of the liming experiments in Rhode Island it was found that a soil which for years had failed to produce good crops without the application of phosphatic manures, was rendered capable after liming of yielding enough phosphoric acid for several successive crops. Similar results have also been noticed in France where superphosphates had first been used without effect.

Roasted Redondite is a phosphatic manure upon which the liming of the soil has a marked influence. It contains little or no soluble phosphoric acid but frequently shows upon analysis as high as 35 per cent. or more of reverted phosphoric acid. If introduced into ready mixed commercial fertilizers in any considerable amounts the proportion of the "available" phosphoric acid actually present as "soluble phosphoric acid" will be much reduced. Hence in goods where the available phosphoric acid is high and the soluble phosphoric acid is very low it is obvious at once that a considerable amount of bone, tankage; or roasted Redondite has probably been introduced. The tendency to use the Redondite in mix-

tures is increased by the high percentage of reverted phosphoric acid which it contains which raises the phosphoric acid which is reported as "available." Furthermore it makes the mixed fertilizers drill far more readily.

Notwithstanding the high percentage of "available" phosphoric acid which it carries it has been found at the Rhode Island Station that this roasted Redondite has but little value for most crops if used upon very acid unlimed land. Liming raised its efficiency for most of the crops tested, in a most striking manner. These results ought to show the importance of putting the soil in the proper condition, if the best results are to be expected from ready mixed commercial fertilizers which contain this material. It is equally important not to go to the other extreme and over lime, for by doing so the tendency would be to lessen the efficiency of the phosphoric acid in bone and tankage.

LIMING INCREASES THE EFFICIENCY OF ORGANIC NITROGENOUS MANURES.

The absence of a sufficient amount of carbonate of lime and the existence of a high degree of soil acidity have already been shown to reduce the efficiency of nitrogen in sulphate of ammonia. If plants are grown which are very subject to injury upon acid soils even nitrate of soda cannot exert its normal effect and much of it will be lost by leaching, before the next season. The danger of financial losses in the case of the organic nitrogen is also great if the soil is very acid and in great need of liming. This is also well shown by an experiment conducted at the Rhode Island Station. The same amounts of potash and phosphoric acid were used in all cases. The nitrogenous substances were applied at such rates as to furnish in every instance identical amounts of nitrogen per acre.

Upon the limed soil the sulphate of ammonia lost its toxicity and the efficiency of its nitrogen amounted to 92.2 as compared with that in nitrate of soda placed at 100. Upon the same basis of comparison with nitrate of soda, the efficiency of the nitrogen in dried blood which was 45.5 before liming was 90.3 afterward, and that of roasted leather was increased by liming from 0.9 to 13.8. Expressed in more direct language,

the value of the dried blood was practically doubled as a result of liming. Such facts as these and those also brought out in connection with certain phosphatic manures, show that the efficiency of fertilizers is by no means always due to the character of the manures themselves, but that the soil is sometimes an equally important factor. Such being the case, the farmer himself is often to blame if good results are not secured, in consequence of his neglect to put his soil in proper condition for profitable agricultural operations.

It would be absurd to claim that the majority of soils in Rhode Island, or that the majority in certain sections of other states, need liming in as great a degree as the soil at Kingston, yet no doubt many individual soils may stand in equal or indeed in still greater need of lime. Even if the influence of these conditions is not ordinarily as great, the kinds of plants with which difficulty is likely to be most quickly met, have now been pointed out, and this ought to serve as a useful guide in liming operations elsewhere. Before leaving this subject it should be stated that even in Rhode Island upland soils have been found which were more in need of liming than the soil at Kingston, upon which most of these experiments were conducted. Furthermore, in the case of most of the soils tested in the five counties of the State, lime was so badly needed that the yields of many of the important crops, such as clover and timothy, were most seriously depressed.

THE NEED OF LIME WIDESPREAD.

The Rhode Island experiments have shown that the need of lime in that State is by no means confined to the Station farm, but that it is more or less general in every county. Since this work was begun experimental data have come to hand showing that lime is needed in parts of Massachusetts, New Hampshire, Connecticut, New York, Illinois, Maryland, Virginia, Alabama, and other States.

One farmer writing from the State of New York says that thanks to the liming hints from the Rhode Island Station he is securing good crops of clover and grass where both failed or partially failed before. Another communication from a farmer in the same State began with an apology for the long letter which he said was necessary in order to properly express his thanks for the services rendered. He had taken up an

"abandoned" farm in a granitic region where abandoned farms and acid soils were common. By the use of lime he had been put in a position so that he was rapidly paying for the farm which the former owner had abandoned, on account of sheer inability to make it pay.

It may not be amiss at this point to show a perfect field of clover where only straggling individual plants were obtainable before the Rhode Island Station called attention to the condition of the soil and the need of liming.

The excellent second crop in cocks in the same field also gives an idea of the good results.

Liming alone without intelligent handling of the soil in other respects is by no means the panacea for the Agriculture of New England. The greatest need of the farmer and his children today is agricultural education. Intellectual, technical training counts, whether the people are white, yellow, or black. The Germans have made it count in their last interval of peace perhaps more than any other nation. We should be prepared to use it in peace and in war if necessary, and to employ it in peace as never before. The sons and daughters from the homes of New England have been powerful factors in the past in leavening the great human lump in this country, and their work is not yet done. Wise leaders are needed today in agriculture as never before and facilities for acquiring some phase of agricultural education of the modern extension and demonstration type should be extended to the vast multitude of New England homes.

In closing this story of liming, practical suggestions and directions for its use have been omitted for lack of time and for fear of wearying a patient audience. These can be had for the asking by sending a request to the Division of Publications, U. S. Department of Agriculture, Washington, D. C., for Farmer's Bulletin No. 77.

Thanking you for your attention and with the highest expectations for the future of the agriculture of Connecticut, I bid you Good-Night!

The PRESIDENT. If there is no further business the meeting will stand adjourned until tomorrow morning at 9.30.

MORNING SESSION.

DECEMBER 13, 1905, 9:30 A. M.

Music.

Convention called to order at 10 A. M., Vice-President Seeley in the chair.

The PRESIDENT. It is a beautiful morning, and I am glad to welcome so many here. It is very encouraging to see such a large audience.

I think the Secretary has some questions in the box.

Secretary BROWN. There are one or two questions, Mr. President, relating to sheep, which we would like to have answered before Dr. Smeed leaves us. The first is: "What should be done with a flock of one hundred sheep that have a few ticks on them now?"

Dr. SMEAD. Mr. President, if I had a flock of sheep that had ticks upon them at this season I would get rid of the ticks. Of course, the question is how to do it. It is very easy indeed. Go about it just as though you were going to prepare to dip the sheep. Catch the sheep and lay it upon its back, put your preparation in a vessel that you can pour from handily. A good thing to use would be an old teapot or coffee-pot that would hold just about as much of the dip as necessary, and from that pour a stream of the preparation along the body and around the skin the whole length of the body. In about one minute or a little less you will discover the ticks are going out from along the backbone and the job is done. Be particular to turn the sheep on its back. The set of the wool is then in such a position that the preparation will take effect. Every particle of the dip runs right to the body and reaches the place where the ticks are. If the sheep is laid in any other way, you will simply have a wet fleece and a dry body. A sheep's wool, you know, is made to shed water.

QUESTION. Why would it not work just as well if you dipped the sheep?

Dr. SMEED. It would.

Secretary BROWN. What is the nature of the mixture you use?

Dr. SMEED. There are a good many mixtures that make a good sheep dip. A strong solution of tobacco will do the work, but I do not consider it the best. Sheep do not like it. A sheep is a good deal like myself. I do not like that, so I do not recommend the tobacco dip. As I stated yesterday, there are several carbolic sheep dips on the market. In fact, there are so many of them on the market that it is hardly worth while to speak about them in detail because undoubtedly many of you have read the advertisements. If you cannot purchase one near by, you can go to a drugstore and get a pint of pure carbolic acid and mix it with a pint of soap, dissolved in any kind of soft soap. Mix it all together in a solution, and use that in the proportion of one part to one hundred of water. The soap is simply used so as to make the carbolic acid a little more solvent. If it is not used it will not mix well with the water. But by mixing it with soap it will mix with the water, and it makes a very good remedy. If you cannot purchase any of these prepared carbolic sheep dips, you can get pure carbolic acid in any quantity you want and mix it up yourself. When the mixture is properly made it makes a very good remedy.

Secretary BROWN. I suppose there are a number of gentlemen in this hall who are interested in poultry. This is not the first time that the State Board of Agriculture has secured speakers upon that subject. A year ago Mr. Delano, of Millville, N. J., presented a paper on "Thoroughbreds versus Mongrels from the Farmer's Standpoint." I have a few pamphlets which contain the address of Mr. Delano, and any member of this audience can obtain a copy by calling upon the committee at the rear of the hall.

The PRESIDENT. The program, for the first thing this morning, calls for an address on "Poultry Management,"

by Mr. T. C. Tillinghast, of Vernon, Conn. You know last night some one was saying that while there were a great many things that the farmers do not have, yet almost every farmer has some chickens. Every man, woman, and child is, to some extent, interested in poultry. Now we are today a good deal interested in poultry, and I am glad that we are to have a man talk to us who has taken a great deal of interest in it, and I am happy to introduce him to you at this time.

"POULTRY MANAGEMENT."

By MR. T. C. TILLINGHAST, VERNON, CONN.

Mr. Chairman, Ladies and Gentlemen:

It is very doubtful if there is any industry in our country in which so many people are engaged or interested as in poultry culture. Most every one keeps a few hens, or at least wants to. They often, if they are not themselves the owners of a plot of ground, find their chickens thriving fully as well on their neighbor's ground or garden. When we consider that the poultry industry is one of the largest in the United States, we certainly believe that it merits the recognition it is receiving here today by the Connecticut Board of Agriculture, and we hope the time is not far distant when its claims will be recognized by our legislature, and that the Connecticut Experiment Station at Storrs will receive an appropriation commensurate with its importance.

I see by the program that I am to speak to you on poultry management. That gives me a very elastic text. I presume anything that I may say on poultry might come under that head. I am very glad to see so many young men present this morning. I think it is evidence, Mr. Chairman, that more than a few are interested in this subject of poultry, and perhaps I could not better use the limited time that I have than by telling you what I think I would do were I a young man and had to start life over again, or, in other words, if I were permitted to return and begin life again. Assuming, however, that I could carry back with me all the information that I may have gained by my experience and observation, I of course would choose the occupation of a farmer, believing that it would give me the largest measure of all the good things that really

make life worth living. The trolley, the rural free delivery, and the telephone are destined to become important factors in removing from the farmer's life that isolation to which he has hitherto been subjected, and to make the farm a more desirable place for a home. I can conceive of no branch of agriculture that to me would be as congenial, and at the same time as remunerative as that of fruit and poultry culture. I believe that the two make an ideal combination. One naturally goes with the other. The people never get quite enough good fruit to satisfy an ever increasing appetite. When we scan the market reports and note the price of strictly fresh eggs at forty, fifty, and even sixty cents per dozen, we are compelled to believe that the poultry industry is not overcrowded, and I believe we have no conception of its future possibilities. In this line of work we need not fear competition from any source. I think it is a conceded fact that no better fruit can be grown anywhere than on the hills of old New England, and the market reports tell us that southern and western eggs are always sold at a discount, while, upon the other hand, fresh eggs coming from near-by localities always sell at a premium.

Now, for a young man to engage in fruit and poultry culture, I doubt if any locality could be found anywhere better suited for such work than right here in old Connecticut. We are blessed with a healthy climate. Land is cheap. You can buy a good farm for less than the cost of the buildings originally erected upon it. We have the best of markets right at our door. And last, but not least, our environment here is all right. We have all the advantages of the twentieth century civilization.

I am aware that many believe that poultry cannot be profitably kept in large numbers. They will tell you that a few hens will pay all right, but when you increase the number you diminish the profit. You will hear it frequently said that a farmer kept forty or fifty hens and made them pay, and made them net him perhaps over a dollar each. Well, that, upon the amount invested, was a better return than anything on the old farm. Some farmers have thought that if fifty hens paid well they could increase their poultry and their profit by adding to the number, but have found to their sad disappointment that a hundred hens did not pay as fifty formerly paid. Hence

they came to the conclusion that poultry on a large scale was a failure. Now if that was the fact, if poultry could not be profitably kept in large numbers there certainly would not be much encouragement in the development of the poultry industry, and instead of my being here today to talk poultry to you, it would have been better had I remained at home. If we stop for a moment to consider methods, I think we will find that the hundred hens were crowded into the same little house that formerly accommodated the fifty. There was ample room for the smaller number, but it made a crowded house for the hundred. And then again the scraps from the table helped to make a balanced ration for the smaller number, but they did not amount to much with the hundred. There was not enough to go around. Now if, when they increased the number, they had enlarged their accommodations, and had supplemented the table scraps by green cut vegetables and cut clover, so as to give them a balanced ration, they, no doubt, would have more than doubled their income. I believe, and I have my past experience and observation to substantiate such a belief, that there is absolutely no limit to the number of fowls that may profitably be kept, provided, as we increase the number, we keep pace with the increase by providing suitable accommodations and a well balanced ration. That is the key to the whole situation. It is the gist of the whole matter. Here is a neighbor, for instance, that keeps a flock of hens, perhaps forty or fifty. They pay well. Another neighbor keeps an equal number and they pay. Perhaps there are a dozen within a very short distance, each of whom keeps a lot of hens, and they pay well. They are practically on the colony plan. Most of the year they have free range, and they get a pretty good balanced ration from the table scraps and from insects and worms they can glean. Perhaps the women take care of them, and, if they do, a good many of them get lots of pin money out of the poultry. If we knew the facts in some cases, I am sure we would find that the poultry pay for a large part of the groceries. The pin money that the ladies get, however, is not the whole story. They get good health. They get needed exercise in the open air and sunshine which the caring for poultry gives. I think if more of our ladies would engage in poultry culture they would find it helpful in more ways than one.

Now in the transaction of any business the labor question enters largely, and is an important factor in determining profit or loss. It does not matter so much at what prices we sell our farm products. If they cost us more to produce than we receive for them, we are the losers every time, but when we can reduce the cost of production to the minimum, we are in a fair way to pay off the old mortgage. Now I wish to try to show you how by adopting twentieth century methods in poultry culture, you can eliminate nine-tenths of the labor in the care of poultry, and still get better results. I know a great many of you think that an extravagant statement, to say that we can care for poultry for only one-tenth of the labor usually given to the work, but that is just what I believe can be done. Now if I could be a young man again, I would want about one hundred acres of land, a farm of about one hundred acres for my poultry grounds. I would want that farm located near some good market, or, at least close to some good shipping point. I would want the land suitable for the production of fruit. Such land generally is all right for poultry. I would like to have that farm well watered. I would like to have a living stream of water passing through the whole farm, or numerous springs upon it, so that water would be easy of access from any part of the farm. Now what would I do with such a farm? Why, I would make that farm a fruit and poultry farm. I would set out about seventy-five acres of that farm in apple trees, with peach and plum trees between. I would set the apple trees forty to fifty feet apart. I believe in letting everything have the sunshine and the air. I would reserve twenty-five acres of the one hundred for the culture of small fruits, such as raspberries, blackberries, grapes, strawberries, and also for the growth of such vegetables as I might need for my poultry. I would also raise some clover. I would have on those twenty-five acres my brooding houses for growing my chickens. Now that would make an ideal place for chickens to develop in. The shade of the raspberry and blackberry bushes would be a protection against hawks and crows. On the whole, I think it would be a safer place than on my neighbor's lawn or in his garden. Then on the seventy-five acres set with the larger fruit I would reserve twenty-five for my breeding stock and for thoroughbred stock. I should expect to have some pretty good birds, and if good birds were worth

one hundred dollars each, why I should expect to capture some of those prizes. I would have my breeding stock also on the colony plan, which I will describe later. Then on the fifty acres remaining of that part of the farm set with the larger fruit, the apples, peaches, and plums, I would use to keep my stock upon devoted to the production of market eggs. That would make a poultry range for that stock of fifty acres. Now I would have the best egg machine I could get for the production of those eggs. From my experience and observation, I should say today that the White Leghorn on such a range gives the best results. We get a fairly large white egg, and an egg that in the New York market brings top prices. I would scatter over those fifty acres my colony houses, built perhaps ten by twenty, and designed to accommodate fifty fowls. In other words, I would put on about four houses to the acre. That is, if I wanted to keep the largest number possible on that number of acres. Of course, you can have the intensive colony system or you can have the extensive. You can let a hundred hens run over five acres if you wish, but I think it is all right on the colony system to put two hundred hens on an acre. If the land was good, they would get all the green food they would require. Therefore, I would stock those fifty acres with poultry at the rate of two hundred per acre. Now I would have my colony houses scattered, and assuming that I have them filled with White Leghorns, I am all ready for business. Now many of you think, undoubtedly, it would be quite a task to care for so many. It would under the old system, but under the new it would be nothing but play. I would not feed my hens over once a week. I would feed them in self-feeding hoppers. I would have my man fill up those hoppers once a week. I would have him fill them with wheat screenings, if I could get them. They are, on the whole, as economical a poultry food as I think we can get. I would have one hopper filled with wheat screenings, and another with beef scraps. That would give them all they need. Then in the winter I would supplement the wheat screenings by giving them cracked corn at night, giving them all they want. There is no danger of a hen that is fit to lay, and that is worth keeping, eating too much of a well-balanced ration. More hens are starved than over-fed with the right kind of food. Snow and corn would not make an ideal poultry food. It would not make

a balanced ration, but those with other materials to balance the ration would do no harm. Now, as I said before, I should want my plant to be well watered. If there is a stream of water running through the place, or there are springs here and there which are accessible to the poultry, it will be a good thing. Hens will go quite a distance to get water, where they do not find it readily and the exercise does not harm them in the least. I would also in the winter feed roots of some kind. Turnips are very easily grown, and after being run through a machine the hens devour them very greedily. Anything in the line of roots you may have, can usually be utilized. I would also have cut clover to give them. I would keep beef scrap all the year. Occasionally, in the orchard I would sow some oats, throwing them into the spaces between the trees, and harrow them in, and then let the hens dig them out. Hens do not consider it work for them to scratch. It is the natural propensity of the hen to dig. As many of you know, they do pretty good work of that kind in the flower garden or in the vegetable garden. Even a little bit of a chick, almost as soon as it is hatched, and before it has learned to toddle around much, commences to dig. You place a hen where she can exercise her natural propensity to dig and it will do her good, and it will be doing good in the orchard. In this orchard of fifty acres you will have ten thousand helpers to assist you in keeping the insects down. I do not think we appreciate the capacity of ten thousand hens in helping to cultivate an orchard. I will guarantee if you will take some screenings once a week, and throw them near the base of your trees, the borers never would trouble that orchard.

Now what would be the proper course to pursue as to water? Some of you may say the course I have pursued is all right in the summer and fall when the ground is bare, because then they could go to the stream or springs for drink, but that when the snow is deep and when it is cold, you say, how would you manage them? I would let them eat snow. I would not water them. But some of you may say, if hens are allowed to look on snow or step on snow it would stop their laying. Well a good many things are said that experience does not bear out. One gentleman said to me last winter at an institute where I was speaking, how do you know that hens will lay where you give them snow? He said that his hens had snow all winter and that he had not gotten an egg. I

asked him if his hens got any grain. And I tried to impress on him the fact that snow and a little grain was not a balanced ration, and that it was necessary, if he would have his hens lay, to give them a well-balanced ration. Give them enough to eat snow will not hurt them. I have experimented with that and I think that is correct. He claimed that the snow would not make good eggs, that the eggs would be all yolk, but I do not think there is anything to that. I have found that the poultry get along very well by eating snow. We want to get rid of as much of the drudgery of poultry keeping as possible. I am satisfied that snow properly given with a balanced ration does not hurt them. I doubt very much if I would let a man water my hens in the winter if he would do it for nothing.

Now most of us before engaging in any new enterprise very naturally want to know if there is any money in it, or whether it can be made to pay. I presume there may be some men and women here who would like information on that question. I presume there may be also some fruit men here, and I think they would tell you that a hundred acres of fruit would net anywhere from one hundred to two hundred dollars per acre. One hundred dollars per acre would be a very conservative estimate. Now you can do a little figuring yourselves. One hundred acres at one hundred dollars per acre from fruit would give a pretty good income, or enough to buy a pretty good farm in old Connecticut. But what of the poultry? There are ten thousand White Leghorns on that fifty acres. If a hen will not net one dollar per head there is some fault in her keeper and not in the hen. One dollar per head is a moderate estimate. A farmer told me the other day that he had fifty hens, and that their product at the ordinary market rate netted him about two dollars per head. Well, ten thousand hens, at one dollar each, does not make a bad income. If you make it two dollars each you can see where it goes. I do not dare to give these figures. Figures will not lie. I will let the boys in the audience do the figuring.

Then again for my breeding stock. I should expect to supply all my neighbors far and near with eggs for incubation, and I would get fancy prices for those; that is, I would get above the market price, and I should expect to have some fine specimens for the shows. I would not show myself, I would

let the other fellow do that, but I would have them pay for the fancy birds I raised. That would help me in the end and be much less expensive. The other poultrymen would soon find out where those fine specimens were raised. I should expect as large an income from the twenty-five acres of thoroughbred poultry as from the fifty acres of market poultry.

Now all these figures seem large, but I honestly believe that they are within the range of possibility. I believe if a young man that has the know-how in him, and has the energy and push to make it possible, he can approximate the figures that I have given. I would not advise every one to engage in fruit and poultry culture, for if I did, and my advice was followed, I should expect in a few years to find a good many abandoned poultry plants scattered over the country. Our talents are not all the same. It is a great thing for a young man to find his niche in life; to find the place he can best fill. We find many misfits all about us. The different professions are crowded with those who are complete failures. They might possibly have met with success had they remained on the old farm. And then again there are those who have spent their whole lives on the old farm and have not amounted to anything. They have barely made a living. It is possible had they followed the avocation of their choice, they might have achieved success. I believe largely in hobbies. I believe that every one should have some high ideal. We find that most of those whose names are written in the halls of fame are men and women of one idea; they have had one supreme purpose in life, and have bent their whole energies and strength for its accomplishment. Life is too short for the average man to become expert in a dozen different lines of work. It is better to be moderately successful in one thing than to fail in a dozen. For those, however, whose tastes incline them to fruit and poultry culture, we believe there is nothing in the line of agricultural pursuits that begins to offer the inducements, both in pleasure and profit, that the raising of poultry and poultry products, according to modern methods, offers.

I think my time is nearly up.

DISCUSSION.

The PRESIDENT. I think an audience like this is quite inspiring. I think it is a demonstration that more people are interested in poultry, perhaps, than in any other branch of the farming industry in our state.

Mr. TILLINGHAST. I forgot to say that I have here some of the plans and models of the hoppers and brooders and things of that kind we use. The feeding hopper is rather a crude model, but it shows the points. Those can be passed around. As to this brooder, there is no patent on it. It can be used by anyone. We find it does good work. The principal advantage of this is that this space here is covered by a piece of galvanized iron. There is about an inch of space between the iron and the floor, and the air goes into all of the four corners. The heat rises from the heater into the pan, permeates over the back of the chicks, and then is forced out. With some of the brooders the same air is breathed over and over again. As you can see, with this, there is no opportunity for the fumes of the lamp to get into the breathing space where the chicks are. There is a circulation all the time of pure air. I have found a brooder of that kind more successful than anything I have ever bought and which costs five times as much.

I will be glad to answer any questions.

Professor BEACH. Will you kindly tell the audience what per cent. of eggs are produced in the winter months from that body of hens?

Mr. TILLINGHAST. That is a very good question. I have no data so that I can give you precise figures. I have always been a little delicate about giving figures. I will tell you why. If I should tell you that I made my hens pay three dollars net, lots of you would say that I lied. I do not want to pass for a liar. If I should come here and tell you that my hens did not pay their keep, why, you would say that Tillinghast was a fool, and I do not want to pass for a fool. No man wants to advertise his failures. On the whole, I will say this. I am in the

poultry business to stay. We are perfectly satisfied with what we are getting. We get all we deserve and all we work for in the poultry business. If there is any failure in any way, it is not the fault of the hen. It is the fault of the keeper.

Professor BEACH. Then are we to understand that you do not know the per cent. of eggs obtained?

Mr. TILLINGHAST. No, I do not.

Professor BEACH. Is it a fact that it is as large as during the summer months?

Mr. TILLINGHAST. In what I have said I have been trying to tell what I would do. I am not here telling what I am doing. I am telling what I would do. I will tell you this, however, that I would not be afraid to wager that I could take hens, taking my own pullets, and commencing the first of November, I could get a half yield from that time to the first of April. I would be willing to put up a wager that I could do it. I know I can get results by working for them. But I am not saying that we are getting that. I am telling these boys what I would do if I was a boy again, knowing what I do now about the poultry business.

QUESTION. Did you ever know of any person who succeeded for five years in getting one hundred dollars per acre from a fruit farm, or an average of a dollar each for ten thousand hens?

Mr. TILLINGHAST. I never knew a party that kept ten thousand hens. I have known a good many who have engaged in poultry culture on the old style. That is, with long houses or in little pens. Those methods have all been written up in books and papers. I am not trying to follow those methods. They knew nothing about the methods I have described. We often read or hear of some rich New Yorker who has gone out into the country and proceeded to establish a big poultry plant, putting in a considerable investment, and organizing it upon a large scale, but in a few years the plant has been abandoned. Now, as I said, lots of farms keep a flock of hens and they

make them pay. There is no question but what they make them pay, and the idea seems to have been spread among them, that while you can keep a few hens and make them pay, you cannot increase the number, but I have proven to my own satisfaction that there is no reason why if fifty hens will pay, with proper care, many times fifty will not pay just as well in proportion. If one colony pays fifty dollars, is there any reason why you cannot spread these colonies over additional space, and by taking the right kind of care, make the additional number pay equally well in proportion? If we can make a hundred hens pay a hundred dollars net, there is no reason in the world why we cannot make one thousand hens pay one thousand dollars. Yes, or five thousand hens pay five thousand dollars, provided we give them as good care and a balanced ration.

Mr. GRAHAM. Mr. Tillinghast, about how long have you been keeping chickens?

Mr. TILLINGHAST. About twenty-five years.

Mr. GRAHAM. About how long have you been keeping them on this colony plan?

Mr. TILLINGHAST. Oh, roughly, perhaps eight or ten years.

Mr. GRAHAM. I understand you have houses for your pullets where you start them, and after you take the cockerels away, you let them grow up gradually and run in with the other hens in the house, is that so?

Mr. TILLINGHAST. After we have disposed of the cockerels, we put the pullets where they eat with the hens from the hopper, and they get their water in the same way, so that they are no more care at all until they begin to lay. I have some which we have not given any care since they were a third grown.

Mr. GRAHAM. I wanted to bring out that fact that the pullets and hens were running together.

Mr. TILLINGHAST. They are running together. The pullets are marked so we can tell them.

Mr. GRAHAM. How long have you been doing that? How many years have you been marking the pullets?

Mr. TILLINGHAST. That is a comparatively new thing with me. We have only been doing that for two or three years.

Mr. GRAHAM. Do you suppose that you have got any hens on your plant over three years old?

Mr. TILLINGHAST. Yes; I have got them there, old grandmothers, six or eight years old.

Mr. GRAHAM. Have you any method of telling how old your hens are, or how many of those hens are over two years?

Mr. TILLINGHAST. I have for the last two or three years. Some of the older ones I cannot tell whether they have passed that age or not.

Mr. GRAHAM. Do you make a practice of culling them out? Do you take the old hens out each year, and put new blood in, or do you leave a hen there until she dies?

Mr. TILLINGHAST. Why, that depends.

Mr. GRAHAM. I understand that your plan is to increase the number each year, and I wanted to know how you kept your stock up?

Mr. TILLINGHAST. If I do not get as many pullets as I want, I keep the old hens. A Leghorn hen will lay as long as she lives, and she will pay as long as she eats. She will not pay as much as when she is younger, but if I want to increase my stock, I take that method.

Mr. GRAHAM. You think that no matter how old a hen is she will pay for what she eats?

Mr. TILLINGHAST. A White Leghorn hen will pay for what she eats and more. There is one thing about older hens. You get better eggs and you get stronger chicks. In my experience I have found a good deal of difficulty in getting pullets' eggs to hatch.

Mr. GRAHAM. You have found from experience that the eggs from older hens are better?

Mr. TILLINGHAST. That has been my experience. I was going to say that I would not set an incubator with pullets' eggs if you would give them to me. I will say this: I would hardly accept eggs that were laid by hens that were kept in little runs and had hot mash and all that. I would hardly accept them as a gift, for I used to keep hens that way and I could not understand why the eggs would not hatch. Sometimes if they did hatch, the chicks would die off like poisoned flies. Die right off in a week or two. I would raise a very small percentage of those hatched. Since I have given my hens free range, I have had no trouble in that way. If I put fifty chicks in a brooder I expect to take out about that number.

Mr. GRAHAM. You are raising a larger percentage of chickens then within the last two or three years, since you have adopted these methods, than you did before, that is, you are raising a larger percentage of chickens that you hatch now than you did four years ago?

Mr. TILLINGHAST. If they die there is always a cause for it. They do not die unless there is some cause. If we find there is a considerable mortality among any lot of them, we try to trace it, and to trace it back to its original cause. If we look carefully we can generally find the cause and remedy it. There is no trouble. To be successful in raising chickens, you want first to give your breeding stock every care. There is where the foundation of your success is laid.

QUESTION. What do you do with your surplus stock, and stock that you want to work off?

Mr. TILLINGHAST. Sometimes we sell it to some one for breeding. It would be all right. Sometimes I would sell them in a pen of ten or fifteen for breeding purposes to some one who wanted thoroughbred stock, and they would get good results. They would be all right for that purpose. If I had anything that was not fit for breeding and wanted to get rid of them, I would sell them to whoever would make the best offer.

Mr. McGREW. Mr. Chairman, I have been listening with a good deal of interest to what Mr. Tillinghast has had to say. He has got the only plant of the kind in the world, so far as I know, and he has been very successful with it. He has made money. I want to bring out a little more clearly the business side of his plant than has been brought out by the questions which have been asked. I have never been at a place where a man seems to grow a larger percentage of chickens from what he hatches than Mr. Tillinghast's. I never have seen a man that handled Leghorns, and got as many eggs and as good results under a special system of management as Mr. Tillinghast, and the point we want to find out, and one which he apparently will not let us find out at present, is what percentage of eggs he can get from those hens, especially during the winter months, under the system that he is using in keeping them. If he will just answer that, it would be a great benefit. I do not know of anybody here who can get it out of him unless he is willing to tell us.

Most of the poultry keepers tell us that if we want to raise four or five thousand hens, and want to get the best results from them, we must not water them early in the morning; that we must wait until the sun is up, and to give them a little lukewarm water. Now this gentleman keeps one, two, or three thousand hens. I think when I was there he had about two thousand, and he tells us that they must depend upon what they get. He is getting eggs from them. Now it would be of great value if he could come before us at some time and tell us what the percentage is, or could tell the world what percentage of eggs he gets from one of his colonies of fifty hens. That is what the people want to know. If Mr. Tillinghast, with his information and ability, could see his way clear to give us that information as to egg yield per month for twelve months from just one of his colonies, he will benefit every single man that is giving his life to the study of poultry. I wish to impress upon him the duty of keeping for the informa-

tion of the poultrymen of the world, a record during the twelve months from the time he goes home tonight of at least one pen, so that a year from now he can tell us what that pen did per month during the year. That is what we want him to tell us, because he is on the road to a great success or a great failure under this twentieth century style of breeding hens.

Mr. TILLINGHAST. I will say to my brother in reply to that, that I hope some time to give the public some figures, but our plant now is in an embryonic stage. We have not been able to keep a record which the public might deem satisfactory. We are sometimes handicapped with help. Sometimes a man that is used to doing all sorts of work about the place gets sick and we have to do it ourselves. All those things enter into the cost. I have had a record which has been kept to the satisfaction of Tillinghast, but not for the public perhaps. Some time I mean to have figures that can be given out. When I get my plant covered with poultry, I shall expect that the figures will mount up into the thousands. I am afraid if I give figures to the public that they would question my veracity.

Mr. GRAHAM. Mr. Chairman, I would say that at the Experiment Station at Storrs, we are taking up that very question. We have now several pens of stock that are getting snow. Those birds have been getting cold water before breakfast since about the first of November. We have several other pens which are getting warm water twice a day, and have been since the first of November. Sixteen pens, I believe. The others are getting cold water. When they jump off the perch in the morning they get a nice cold drink. Before very long we will be able to give you some data.

Mr. TILLINGHAST. How do those birds do that eat snow?

Mr. GRAHAM. We have only had snow a couple of days, Mr. Tillinghast.

Mr. STOCKMAN. The gentleman says on the platform here that he is not telling what he does but what he would do on his ideal one hundred acres. I would like to inquire if he is

using this method to any extent on his poultry plant at the present time. I have kept poultry more or less for some time, and twenty-five per cent. of my hens are laying now, but I am not feeding them snow for drink.

Mr. TILLINGHAST. I would advise the gentleman to try one pen with the same method, to give one pen snow and the others water. Perhaps the first day the snow might not have the desired effect. I think a hen wants to get used to the condition, perhaps, or to the use of snow. I will guarantee, however, that you will get eggs from snow. A gentleman came to my place about two years ago. He had about a hundred hens. He was not getting the eggs he should. I showed him some pens that had not had anything but snow all winter, and I was getting about two-thirds from those pens. I said to him, "If you will follow my prescription, you will get eggs in two weeks' time." "Why," he said, "I will do anything." I asked him how he fed his hens. He said he carried down some warm water about eight or nine o'clock in the morning, and then he gave them some potato peelings and such, and then scattered a little corn in the winter. "Why," I says, "your hens are half starved." "Why," he says, "they tell me there is danger in getting them too fat." I told him to get a bag of wheat screenings, and a bag of scraps, and to give them all the corn at night they would eat; to never mind about the hot water, but to open the little door so that they could help themselves to snow. I asked him to try that plan and then report. The next time I saw him he said he was getting eggs from the hens and had not watered them at all.

Secretary BROWN. I do not think the speaker has answered the question of the gentleman from Morris. The gentleman from Morris asked Mr. Tillinghast if he pursued the methods that he would pursue if he was a boy again.

Mr. TILLINGHAST. Why, that would be self-evident. Any method that I would pursue with the information I have gained by experience and observation I would certainly pur-

sue if I were to start over again. I am practicing whatever I am preaching. Most certainly, I am using the method that I am speaking of.

QUESTION. I would like to ask the gentleman this question. He says he has four brooding houses on an acre. How does he keep those hens properly divided up? Do you have a wire fence between the houses?

MR. TILLINGHAST. We have no fence except the fence around the whole place to protect the stock from dogs. Dogs sometimes get in, and we have lost at times a good many hens. We have no division fences except between the breeding and laying stock. The stock on our fifty acres is our laying stock. We do not keep any cockerels there, but we are keeping that stock entirely for the purpose of raising market eggs. We have those houses scattered about, and there is no difficulty in getting the hens to divide themselves up properly among the houses. If you have ever noticed, where there has been a brood of chickens, and you try to get those chickens into the hennery and notice how tenacious they are to get back to the house. It is the same way when they grow up. It is an old saying that a hen will come home to roost every time.

QUESTION. I understood the gentleman to say that he only fed his chickens once a week, and then later on he said something about feeding them every night. I would like to understand how he does, if he only feeds them once a week.

MR. TILLINGHAST. We feed just once a week. That is, the hoppers are filled once a week. Of course, in the summer, we do away with the cracked corn. We feed cracked corn more to give color to the yolks. In the winter if you feed a hen on wheat screenings altogether, the yolk is not so desirable. If you want to make a bright golden yolk, the corn is better. We supplement the other food in the winter with cracked corn because I want the hen to eat all she can, and corn does no harm, even if she does eat all she can of wheat screenings. If this is given at night, the hens have a long time to grind it up through the night.

Now on a place of fifty acres of fruit, instead of buying fertilizers, commercial fertilizers, fine bone, and such things, I would not bring the fertility of the west here to the east, but I would buy my corn by the carload and let the hens grind it. Also feed the cracked bone and let the hens grind it. They will grind it finer than any mill can do, and give it back to you in a more available form for plant food. So in this way we have a double profit. We have no fertilizer bills.

QUESTION. I would like to ask Mr. Tillinghast if he has ever used the stuffing process.

MR. TILLINGHAST. I never have.

QUESTION. Do you consider it any advantage to feed warm food once a day to your poultry?

MR. TILLINGHAST. Why no. Not any great advantage, and yet if I had certain material that I wanted to get rid of, if I could not feed it well in a hopper, perhaps in the winter if I had help that was not doing anything, I could feed it that way. I would not want to feed it to breeding stock. I prefer to feed the flock as much as possible from the hopper. About twenty years ago, when I commenced, I was away from home a good deal through the day, and did not reach home at night until four or five o'clock. At that time I found my poultry was all on the roost. It was too late to feed them. I used to get up at five o'clock in the morning and give them a hot food. I thought I had to do it. And then at noon I gave them some kind of grain to scratch for, and at night I used to give them corn. That practice was not very satisfactory. I conceived the idea of making a kind of hopper. I had a little boy about five or six years old, who was old enough to do what I told him as near as he could. I put the grain in the hopper, and had the little boy, about three o'clock, go out and open the door to the hopper. His mother would send him down to open that door. The hens could get it at that time and go on the roost with full crops.

One advantage of this system of dry feeding from a hopper, is that you can get along with less intelligent labor. Most any man is intelligent enough to fill a hopper, but it requires more or less of an expert to feed soft food. I have had men, and they would overfeed or underfeed. If too much was placed before the fowls, then it was left to sour and spoil, and, as a consequence, I used to have fowls in the hospital a good deal of the time. I have no use for that system now. The hens are kept now under natural conditions. We are bound, of course, to lose some under the best conditions.

QUESTION. I would like to ask the gentleman if he can give us some more details of his houses and what they cost.

Mr. TILLINGHAST. I think there are some papers here doing that. I take quite a number of poultry papers. The "Feather" is a good paper, and there is a picture here of the colony houses, and instead of explaining the details, I thought you would get a better idea if you took that and examined it. You can then see the way it is built up.

The PRESIDENT. I think, gentlemen, that we shall have to leave this discussion temporarily. We have another gentleman who is going right on with the same subject. Mr. Hunter is going to speak to us. We should be glad to have him come forward and tell us about "Dry Feeding; the new Poultry Culture."

DRY-FEEDING; THE NEW POULTRY CULTURE.

By MR. A. F. HUNTER.

For many years past there has been a growing dissatisfaction with both the methods employed and the results attained in our poultry work. The methods employed have involved an excess of labor and the results attained have been, in far too many cases, disappointing—the disappointments taking the form of poor health of flocks of both mature birds and the young chicks, resulting in a lowered egg-yield, increased mortality, diminishing profits, and in very many cases an abandon-

ing of the poultry business. That there may be many contributing causes to the unsatisfactory results has been conceded by poultry writers, among them unsanitary conditions in the houses and ground of yards poisoned by the droppings, vermin infestation, stock debilitated by inbreeding and breeding from late hatched and consequently immature pullets and cockerels, bungling methods of feeding, shutting the birds up in tight houses, etc., etc., etc.,—any or all of these may have helped to the unsatisfactory results above noted.

In the last few years observing poultrymen have been experimenting along two different paths, in the hope of finding aids to better results; one of these paths being to more and more open up the houses to fresh air and sunlight, the other being a better and more common-sense method of feeding; the first of these we have not time to study in detail, merely pausing to observe that it is a decided gain in method, and substantially improves the conditions of health in the flocks—the second, that of feeding, gives us all the range we have time for today.

That quite a good deal of the trouble we have been having with our flocks was due to defects in methods of feeding has come to be the opinion of many observers, and of late the feeling has been gaining ground that the feeding of a cooked mash is a serious mistake. One reason for this is found in the fact that the fowls gobble the food down very quickly, far too quickly for the digestive organs to properly perform their allotted task, and the results have appeared in the form of indigestion, looseness of the bowels, and other symptoms of the birds being out of condition. Not infrequently the birds have become over fat, the organs become engorged, a blood vessel bursts, and a fowl is found dead under the roost in the morning. The explanation of this is that feeding a cooked mash is "forcing" the birds beyond their ability to digest and assimilate; it is analogous to "forcing" for rapid growth of tender, delicate flesh for market, and the process is all right for chickens that are to be early killed for the table; for that definite purpose the quicker the growth the greater the profit. But for birds that are to endure the strain of persistent egg-production, and are to be the parents of strong, vigorous, bound-to-live offspring, the "forcing" process invites disaster, because it induces and continues a condition of tenderness, which is

exactly opposite from the hardness so desirable for the best results.

The conviction that feeding a cooked (or wet) mash is a mistake is well illustrated in the statement of a poultryman, writing in one of the poultry papers, who says: "When I want to force the birds to heavy egg-production, I feed a cooked mash, but when I want to get good strong-bodied eggs, eggs that will hatch out a large proportion of strong, vigorous chicks, I feed the breeding pens a dry mash and all dry grain — and I get eggs that will hatch!" There is a clear statement of the conviction that mash feeding is a mistake if we want the limit of strength and vigor, and who does not? It is clear that not only the best of health and strength is desired by all who want the best profit from their flocks, and it is being demonstrated by experiment that the best and most continuous egg-yield is gotten by a radical departure from the cooked-mashed method of feeding, and adopting the method suggested by our friend quoted above, of feeding the mash dry and supplementing it with the usual feeds of dry grains and seeds.

A farmer in Illinois tells his experience in feeding, and how he came to adopt the dry-feeding method. He says: "After reading much upon the subject I concluded the greater part was nonsense, and I now fully believe that inside the next ten years feeding poultry in every stage will be much simplified. I have had some experience in growing hogs, and did considerable experimenting with feeding. I found that by using ground, mixed grain, fed dry, I could grow a prettier, more shapely, and firmer fleshed hog, than by feeding a slop.

"Nothing under the sun fed in its natural state will blow up a pig to such an extent as a rich slop, and no pig so fed will have the fine symmetrical appearance of one that is fed more in accordance with nature. I fully believe the slop-feeding is destructive of the digestive organs of the pigs, and also fully believe the mash business for chickens and hens gives the same unfortunate result. Any mash will begin to sour soon after being eaten and subjected to the heat of the body, and this too early souring of the food in the crop, before it is properly passed on to the gizzard and intestines, is the foundation of sour-crop and bowel trouble. I will guarantee you that if cracked or whole grain is given regularly (and not in spurts

now and then), examination of the crop at any time will not reveal that sour smell so frequently noticed in mash-fed hens.

"When dry-fed, a chick or fowl will not gulp down a great amount of the food at one time, and I fully believe that with dry feed, moistened with saliva, it will not sour nearly so quickly as if it is moistened with hot water or milk. If my method of feeding will grow good, healthy Plymouth Rock pullets to weigh seven and one-half to eight and one-half pounds in seven to eight months, I believe that pullet is in better shape to lay, and, if continued on dry food, will at two years of age lay as many or more eggs than will a mash-fed chick and hen; and not only this, but the eggs will be larger and more fertile, and when you come to sell the carcass it will have both a better appearance and better weight. I know the eggs I am getting now are better in size, color, and shell than any I ever bought; I mean thirty-five to fifty per cent. better in quality, and this I attribute to my having adopted the dry-feeding method. I am certain that dry food properly fed means health, with no sour-crop and no bowel trouble.

"When I began dry feeding I had never seen an article upon the subject. I knew I could do better with hogs on dry food, but had never studied why. I knew I had too much to do, was too busy with the farm work, to grow chickens with mash. I planned my year's campaign before a chick was hatched, that is, the best of grain and sweet milk before the chicks all the time, beef scraps also and charcoal accessible all the time, with clover-hay chaff for litter, and good range. I have experimented with dry feed for chicks for two years, the past year for all ages of poultry, with the best of success."

That tells us how a busy farmer out in Illinois worked out a better method of feeding his flocks, better because it cut down the work fully a half, and gave him better results, both in growth of young chicks and in egg-production. He had learned that he grew a better looking hog, and one that the meat of was firmer and better, by feeding it on dry grains, and he argued that if all dry grains were better for a hog the same method of feeding would give better results with chicks and hens. This farmer "put brains" into his work, and an eminently satisfactory saving of labor combined with a bettering of results, was his reward.

Here is another writer's argument: "Well-bred chicks are naturally hardy. Chicks born of strong hardy parents come into the world about as well fitted for the battle of life as anything we know of. Given half an opportunity, fed within the bounds of reason and common sense, and properly brooded, it seems almost impossible to kill them. They have an ample coat of down which protects them from almost all kinds of weather for short periods. Given a well regulated brooder they will cheerily run out into an almost zero temperature, and apparently be as happy and contented as though it was warm summer weather, and they certainly grow much better than when placed in what some call better conditions. They eat a mouthful or two, kick up the scratching litter in search of a tidbit of seed or grain, and then scamper back under the cover for a minute's warming, and they certainly grow much better than when placed in what some may think more favorable conditions. Fed improperly, or kept at too warm a temperature, or when they are so unfortunate as to have had weak parents on one or both sides, the reverse conditions seem to be the result—they are about as delicate, puny, and unsatisfactory atoms of mortality as the world produces.

By closely studying nature's methods with chicks, we find that the mother hen, leaving the nest when the chicks are from one to two days old, does not have a chance to lead the way to a dough dish and fill them up with an indigestible mess of dough. On the contrary, she starts out on a hunt, if she is undisturbed, she makes a good display by nightfall, and has succeeded in filling the crops of her numerous family. If we could dissect those crops we would not find a scientifically prepared mixture of one to four, or one to five, or "sixteen to one," or any other startling array of chemical combinations; instead we would find a bug or two, a worm, some seeds that we may have carefully planted in the garden a day or two ago, together with a variety of weed seeds, and plenty of grit. This composite mass has been gathered together in ten or twelve hours' time, with a liberal sprinkling of exercise thrown in, and if the weather conditions are favorable and the mother hen does not drag the youngsters around through the wet grass too much in the morning, she usually comes out at the end of the season with as many full sized chickens as she started from the nest with.

Instead of this common-sense method of feeding chicks, the usual way, when the old hen brings off her brood, is to shut her up in a coop and dump down on a board in front of the coop all the wet dough she and the chicks ought to eat in a day's time. Some of this is eaten, but most of it is trampled into a door mat for the youngsters, and in an hour's time looks much like the dirt surrounding the coop. Exposed to the hot sun, it does not take long to start the process of fermentation, and we soon have the germs of bowel trouble growing at the rate of forty miles an hour! The books say that chicks should be fed five times a day, and the nervous owner argues that if five times is good, six times is better, and soon comes around with another mess of wet dough which he deposits on the top of the first "charge," and there is now a sandwich of dough and dirt. In a few days' time the chicks begin to drop off one by one, the common manifestations of bowel trouble, such as pasting up behind and watery diarrhoea, are in evidence, and the owner begins to "darn the chicken business" or else he blames the man from whom he purchased the eggs for having inbred stock, and we have another of the many cases of "the chicken business don't pay nohow!"

"Perhaps our friend's more painstaking neighbor improves upon this method and bakes the mash into a sort of bread, which is a decided improvement, because it removes the greater part of the water, but at the same time it considerably increases the labor. His chicks certainly do better, and make a very good growth for a few weeks, and he begins to boast that the solutions of the poultryman's troubles lies in cooking the food, so he invests in an amateur bakery and bakes everything. His chicks apparently continue to thrive, but as the weather gets hotter he notices some bowel trouble among the half-grown birds; these die and he shouts that cholera has struck him, and writes to the editor of a poultry paper, who tells him it probably is cholera, as the symptoms he describes look like that. After changing the method of feeding once or twice, and losing half of his flock, he gets around to feeding hard grain and pulls the remainder of them through, although they are not now as large, nor nearly as healthy as chicks raised under the natural method and without the assistance of a bake shop!"

This graphically describes a common experience in feeding chicks, but does not explain the cause of the difficulty, which may be defined as, in part at least, a too rapid eating or "gulping" of the food. One poultry writer describes it as follows: "Your mash-fed chicken gets up in the morning, waits around an hour or two until the feeder gets ready to bring along a bucket of hot or cold mash, which is thrown down on a board or trough and a wild scramble begins. Each one gulps down what he can reach; the weaker get a little and the stronger get the bulk of the food. If the mash is hot it raises the temperature of the bird above what is normal, and perspiration is started, which is far from what should be, as this opening of the pores of the skin paves the way for a chill and the foundation of colds and roup is laid. The food goes through the crop with very little change except fermentation, and the extra work of preparing the food for digestion is thrown upon the gizzard and intestines, whereas the saliva of the mouth and kneading of the crop should have done quite a little towards softening and partly digesting it.

"The cooking of food, some say, makes it more digestible, which we have no doubt is true, but the question arises as to what particular part of the food it makes more digestible. Of course, the starch is more easily digested, but the protein is not, and we think that here is where the mischief arises from cooked food. The simple scalding of a mash makes no chemical change in it; you may just as well mix it with cold water as hot, the chemist tells us. The writers say mix the mash as dry as you can mix it; if it is better to mix it as dry as possible, why is it not better to leave the water out of it entirely? Surely, it is very much easier to mix it dry than wet. 'But,' it is objected, 'the fowls won't eat it!' This is true. They will not eat the dry mash for a day or two, when they have been brought up on the wet-mash ration, but brought up on the dry mash they eat it freely and whenever the appetite prompts, and it never stands before them sour — the last spoonful in the hopper is as sweet as the first.

"Furthermore, each bird gets its full share. There is no wild scramble for the heaps of wet mash in the trough. A bird goes to the food hopper and eats two or three mouthfuls of the dry mash, taking time to turn over and properly moisten it with saliva, and then turns away to search for other bits, as a seed

or two, or a grain of wheat, or oats, or barley, or kernel of corn; there being no frantic scramble for the feed-hopper there is ample time for each bird to help herself to all she wants, and they all get their full share.

"The pith of the argument for dry-feeding lies in that eating slowly, a bit at a time, first a mouthful of dry mash, then a bit of grain, or a seed or two, and then a snip at a clover leaf or head, then to the drinking fountain for a sip of water. It does not take us long to discover that this is exactly the way the fowl or chick eats when running wild and finding its food bit by bit—it is 'nature's way' for a bird to feed, and if we but do our part in supplying the essential food elements so the birds can take what they want and as they want it, the conditions seem to be right for them to eat in the natural way, and they will eat no more than they want and eat it in the way their systems can best appropriate it."

Dr. Nottage, of Goshen, Mass., who is a sturdy advocate of the dry-feeding method, says: "To better understand the advantages of dry-feeding, let us look at the method I employ in using the grains. The fact that I have gotten rid of mixing and cooking mash, and am now feeding most of the grain and for the greater part of the time from feedhoppers, shows how much easier it is to care for a good sized flock of fowls. The advantages are apparent to all who feed their flocks four or five times a day, and are constantly fussing with them. I have come to be spoken of by the farmers around here as 'the man who feeds his hens twice a week,' from the fact that during the growing period, from the incubator to the pullet that is about beginning to lay, I feed all the grain and beef scraps from feed hoppers, which I fill twice a week. Keep in mind that all young stock is on free range, and the laying birds in yards so ample they seldom wander to the ends of them; also that this laying stock is let out to wander at will on alternate days.

"I would not advise changing suddenly any method of feeding, as it will seriously affect the egg output for a time; but after a few days the hens will be laying as before. The best way is to begin with the chicks right from the incubator. Looking at the subject of feeding from the beginner's standpoint, I am certain that fewer mistakes will be made and a larger number of chicks raised to a healthy maturity by feeding

dry grains and beef scraps from feed hoppers kept constantly filled, provided the chicks can run upon grass range. There will be seen no rushing and trampling crowds of chicks, but a contented and lively set of youngsters that are plump, healthy and happy, although on free range, where some people think they are likely to run all the flesh off their bones! They will also find time to dig holes in the dirt, lie under the shade of the trees and enjoy life. He will be surprised at the rapid growth of his stock, if it has any 'grow' in it. More of this when we speak of results. Do not get the idea that an experienced poultryman cannot produce like good results with his mashers, for he certainly can. However, let a beginner start with mashers and they will often become 'messes,' and more chicks will drop out of the race than if he adopts the plan that I pursue with mine.

"Have plenty of grit where the chicks can pick it up for their first meal. Get your miller to mix together one part of good sound wheat to two parts good sound corn and crack them a little finer than common cracked corn. Put a small heap of this in the front of the brooder, and beside it a small heap of dried beef scraps, from which the coarser pieces have been sifted out; this sifting out of the coarse pieces to continue till the chicks are big enough to eat the scraps as they come to hand. If you have skimmed milk, keep the youngsters on that for a drink until they become a little tired of it, which may be in two or three weeks; you can let them have their choice between milk and water. If there is not a green sod for them to pull and work at when they get into their second week, chop up some onions, or lettuce, or cabbage, and let them have some once a day. Get them out on the ground as soon as there is a blade of green grass to be seen pushing up through the sod.

"You can carry the birds along on the ration of half wheat and half cracked corn, with the beef scraps added, until the pullets are about half grown, say ten to twelve weeks old, then the grain ration is gradually changed by the introduction of the best grade of oats till in a couple of weeks it will be a fourth oats, a fourth wheat, and half cracked corn, and on this ration they are left to grow to full maturity. The addition of oats to the hoppers is to strengthen the body-building side of the ration, oats being the best body-builder of all the grains.

In this simple way it is possible to grow good, strong, healthy layers, and not have one bit of fuss about 'balanced rations' and forty different kinds of food. When the pullets show signs of getting ready to lay, which they will do by October first, if they are hatched in April, it is high time to get them into the quarters they will occupy during the winter, and it is now time to change the manner of feeding somewhat."

The food for the laying hens is in a food-hopper which is divided into three compartments, each holding about half a bushel; in one compartment is a mixture of one-half barley and a half cracked corn, in the middle compartment is the beef scraps and in the other whole oats. This food is there in the hoppers all the time, the hoppers being re-filled twice a week, and never being empty, and they eat of either or all of them just as they choose. It is evident that if the hoppers were sufficiently large to hold a full week's supply of grain, they would only need to be filled once a week, and then the Doctor would have it told of him that he only fed his hens once a week!

The question of green-food supply, here in our rigorous climate, where snow covers the ground for many weeks and some winters as much as four months, is an important one, and the question is frequently raised as to feeding something warm, "to warm up the birds when they come off the roosts." If one has the feeling that he must feed something warm, by all means make it a feed of steamed clover, cut in half-inch lengths, and the green-food supply will be covered at the same time. The freshening of the cut clover by either steam or hot water makes it more palatable, makes it considerably like new-mown hay before it is cured, and the fowls relish it greatly. They also relish the cut clover dry, and some progressive poultrymen keep a wire-netting pocket of cut clover hanging against the wall of each pen, the clover being cut in half-inch lengths and a half-bushel at a time put in the pocket. The fowls eat a good deal of it. The usual green foods, such as beets, turnips, carrots, cabbages — any of the vegetables commonly used for this purpose, can be fed just the same when the grains are fed in hoppers as when the old-time mash breakfast was fed, followed by the noon and night feeds of grain in the litter.

Another prominent poultryman's method of dry-feeding he describes as to give the chicks a mixture of assorted grains and grit about the size of a pin head for their first food. With a dish of beef scraps standing constantly before them, and the fine ground food thrown in litter, with plenty of green food (cabbage or green grass), they have an inducement to scratch from sunrise to sunset, and they take the food slowly and naturally. With the beef scraps always within reach, they at no time crave more animal food, their systems rapidly adapt themselves to a season of plenty, and nature constructs a body planned for a continuation of this same diet, namely, good, thick, strong leg and frame, and a chicken that looks ready to eat at any stage of the game! Long-bodied, short-legged, hardy, "born-to-live" looking fellows, free from all the ills and pains of chickendom, and fit to wrestle for a living through thick and thin, through good weather and bad, so long as the food holds out.

"When they reach the age of six to eight weeks, we gradually wean them from the small grains and substitute cracked corn and wheat, place them in colony coops on grass range, and soon discontinue the wheat, feeding cracked corn and beef scraps in hoppers, feeding once a week or oftener as the size of the hopper and number of chicks demand. These food-hoppers should be made quite high in front, three inches at least, as the birds are always trying for the larger pieces of beef scraps, and with a low front to the tray of the hopper they waste quite a little by throwing it out with their bills. The hoppers should be covered with waterproof paper to prevent the food becoming wet, if they are placed outside the roosting coops; an excellent plan is to have a small 'shelter' to put the food-hopper under; this will protect it from the rain and give the birds shelter also — a double advantage. This system continues until the sexes are separated, and then we place the males in yards sufficiently large so the birds never eat them bare of grass. Putting the cull cockerels which we intend to market in pens by themselves, we compound a mixture of equal weights — corn, wheat, oats and barley, ground as fine as flour — if we can induce the miller to reduce it to that fineness — feed it dry and continue the beef scraps as before. This method of feeding market cockerels has given us fatter chickens than we have ever been able to produce by any other method.

"A mixed lot of cockerels is about as uncomfortable a set of individuals as is ever gotten together, and this method of feeding is the only one by which each bird can be fed singly and all get a full share. Here each one goes to the hopper and eats as long as he has plenty of saliva to moisten the food, then moves away, allowing a weaker brother to come up and take his turn. They must necessarily eat slowly, because they can swallow only a small amount of this dry mixture at one time, and thus all have an equal opportunity at the food.

"Here the digestion of the food begins in the mouth. If the crop of one of these birds is cut open, in place of the sour, partly fermented mess that is found in the crop of a mash-fed chicken, we find the grain as sweet as ever, but smelling as though partly cooked; there is no fermentation of any kind, and we think the crop now does the work nature intended for it to do.

"With the system of dry-feeding and the chickens on range, the hopper of food awaits them immediately they are off the roost in the morning; they eat a little and then start upon the day's hunt over the fields for the bugs, worms, grasshoppers, and grass, which go to make life one sweet dream for them. At any time during the day that their appetites dictate, they can call around at the coop, get a supply of such grain and meat food as they desire, and eat it unmolested, and in a gentlemanly and ladylike manner. Much more uniform gains result; the younger and weaker chicks thrive as well as the larger and stronger, summer chicks grow practically as well as the spring hatched — and bowel trouble is a thing unheard of from the shell to maturity; the essential things are that the proper heat be maintained in the brooders for the baby chicks, plenty of room in the coops for them to be comfortable as they get older, and that the grain and beef scraps used are of the best quality.

"When the pullets go to the laying houses they are fed cracked corn, wheat, oats, and barley; fifty per cent. of this, however, is cracked corn. A hopper of beef scraps is kept constantly before them, and we now add a hopper of dry bran. The whole grain is thrown in litter two or three times a day, as convenience dictates. The birds are made to scratch for all of their grain, and there are cabbages for them to eat constantly before them. If cabbages are not plenty we use cut

clover, scalded to soften it, fed in deep troughs. We have used with excellent success a dry mash, consisting of twenty-five per cent. corn meal, twenty-five per cent. beef scraps and fifty per cent. bran, *fed dry* in boxes during the morning, giving what they will eat up by noon, when we give a light feed of whole grain, with a full feed at night. Hard grain is thrown in litter, as previously noted, and while this ration is a little cheaper than the other, because the dealers put the poorer grades of corn into their meal, the results are not always so satisfactory as we could wish, and for that reason. A good egg-yield will result from this ration if the ground grain and beef scraps are of good quality. We have no difficulty in getting birds to one or two pounds above standard weight by this method, and we want to say that we believe that ninety per cent. of the chickens raised in this country do not have sufficient quantity of the right quality of food; what is called over-feeding we believe would be more correctly expressed as improper feeding!

"There are very few breeds that would get too fat to lay if properly exercised, and we have yet to find one of our birds in this condition.

"As to fertility, and the strength of the germs, we believe no system of feeding can equal this method. The eggs uniformly test well, and the germs live through and hatch good, strong, bound-to-live chicks that are ready to take up the dry-feeding method as their ancestors did. No weaklings result, provided the other conditions surrounding the birds are right — one of the most important of which is an abundance of fresh air, and our fowls will stand an almost unlimited amount of this if the houses are free from draughts and they are not subjected to the daily sweating over a hot mash. Each generation of these youngsters seems hardier than their ancestors, are more cheaply raised, for any uplifting of the general health of the flock must be reflected in the decreased mortality of the youngsters.

"The labor saved is no small item, for the difference between feeding the chicks three times a day with grain, plus the cooked Johnny-cake, or heating the water and stirring up the mash for a large flock of hens — and having the food always accessible to the chicks in summer, and the dry mash with throwing the dry grain in litter in winter, amounts to a saving

of a third to a full half of a man's time and physical energy — all of which we have demonstrated to our complete satisfaction is labor wasted. This labor directed to other details, and the poultry work is full of them! — will grow the chicks and care for the flocks much better, or will allow double the numbers to be kept with the same number of steps taken daily. Experiment has demonstrated that quite as many, if not more, eggs will result, than from the mash-feeding system, and any old stock that is kept over will be found to lay nearly as well the second year as the first, the birds lay better through the molt, there is less mortality among the adult birds, and the profits will be found to be on the right side of the ledger when the accounts are made up."

An excellent test of the dry-feeding method was made at the Maine Experiment Station this last year, the report, given in Bulletin No. 117, of that station, confirming many of the claims made by the advocates of the dry-feeding method of rearing chicks and feeding adult fowls. After describing the former method of feeding the chicks, which includes two feeds of mash a day, the bulletin says:

"Until last season we had continued feeding two feeds of cracked corn and wheat and two of mash daily as long as the birds remained in the field. Last June we had 1,400 chickens well started, and we changed the plan of feeding by keeping cracked corn, wheat, and beef scrap in separate slatted troughs where they could help themselves whenever they desired to do so. Not more than one-fourth of the grain was wheat for the pullets, while in the cockerel division, nothing oyster shell were always supplied. There were no regular but cracked corn and beef scrap were fed. Grit, bone, and hours for feeding, but care was taken that the troughs were never empty.

"The results were satisfactory. The labor of feeding was far less than that required by any other method we have followed. The birds did not hang around the troughs and over-eat, but helped themselves — a little at a time — and ranged off, hunting or playing and coming back again when so inclined to the food supply at the troughs. There was no rushing or crowding about the attendant as is usual at feeding time where large numbers are kept together. While the birds liked the beef scrap, they did not over-eat of it.

"During the range season — from June to the close of October — the birds ate just about one pound of the scrap to ten pounds of the cracked corn and wheat. They had opportunity to balance their rations to suit themselves by having the two classes of food to select from always at hand. It would seem that we had not been far wrong in our previous feeding, as the birds used just about the same relative amounts of scrap to other food, when they had liberty to do so, that we had formerly mixed in for them.

"We are not able to say whether this method is more or less expensive of material, than when we fed the four feeds each day at regular hours. As near as we could calculate, there were no appreciable differences.

"The birds did well under this treatment. The cockerels were well developed and we never raised a better lot of pullets. The first egg was laid when the oldest pullets were four months and ten days old. For the last six years the pullets have been from four months and ten days to four months and twenty days old when the first eggs were found. This year we shall make another change by adding dry mash to the menu — having a trough of that material besides the ones containing beef scrap and cracked corn. The difficulty of keeping the food clean and dry during continued exposure is nearly overcome by using troughs with slatted sides and broad, detachable roofs. We make them from six to ten feet long, with the sides five inches high. The lath slats are two inches apart and the troughs are sixteen inches high from floor to roof. The roofs project about two inches at the sides and effectually keep out the rain except when high winds prevail.

The roof is very easily removed by lifting one end and sliding it endwise on the opposite gable end on which it rests. The trough can then be filled and the roof drawn back into place without lifting it. This arrangement is the best of anything we have found for saving food from waste and keeping it in good condition. When dry mash is used in it, there is considerable waste by the finer parts being blown away. When used for that purpose it is necessary to put it in a sheltered place out of the high winds."

The dry-feeding was continued with the pullets thus raised, with decidedly satisfactory results. The report says:

"On the first of last November we began feeding 550 April and May hatched pullets wholly on dry food. They were in the curtain-front houses with warm elevated roosting closets and in flocks of 50, 100, and 150. At five o'clock in the morning the flocks of fifty birds were given two quarts of cracked corn; at half-past ten they had one quart of wheat and one quart of oats. This dry material was all spread on the litter on the floor but was not raked in. Along one side of the pens were feed troughs with slatted fronts, in which was kept a supply of the dry material of which the moist mash, before described, was composed. These troughs were never allowed to remain empty when the supply was exhausted. The dry mash was constantly within the reach of all birds and they helped themselves at will. Oyster shell, dry cracked bone, grit, and charcoal were accessible at all times. A moderate supply of raw mangolds and plenty of clean warm water was furnished them. When they were first put upon this ration they were not acquainted with the dry mixture in the troughs and ate of it sparingly, but in three or four days they were using as much of it as at any later time until they got to laying heavily. When the feeds of cracked corn, wheat, and oats were given, the birds were always ready and anxious for them and would scratch in the litter for the very last kernel before going to the troughs where an abundance of food was in store.

"It was very evident that they liked the broken and whole grains better than the mixture of the fine materials; yet they by no means disliked it, for they helped themselves to it — a mouthful or two at a time — whenever they seemed to need it, and never went to bed with empty crops so far as we could discover. They apparently did not like it well enough to gorge themselves with it, and sit down, loaf, get over-fat and lay soft-shelled eggs, as is so commonly the case with Plymouth Rocks when they are given warm morning mashes in troughs.

"Some of the advantages of this method of feeding are that the mash is put in the troughs at any convenient time, only guarding against an exhaustion of the supply, and the entire avoidance of the mobbing that always occurs at trough feeding when that is made a meal of the day, whether it be at morning or evening. There are no tailings to be gathered up or wasted as is common when a full meal of mash is given at night. The labor is very much less, enabling a person to care for more birds than when the regular evening meal is given.

"We cannot give the results of a full year's feeding in this way, as we have practiced it only from the first of last November to the close of June. The number of hens lost during the winter has been less than ever before, even when they were kept in the same style of houses. We can ascribe this to no other cause than that the birds did not overload with food at any time. We have never had so many eggs laid during the winter months by a like number of hens, but that may be due to better breeding, or to the open-front houses which the birds occupied.

"During the months they were not laying heavily, the consumption of mash was but about four pounds and the demands for shell, bone, and grit were less. It will be noticed that the proportion of wheat fed was less than in any former ration we have fed and that the cracked corn was increased, thus cheapening the ration.

"The average yield of the 550 hens during March was 20.4 eggs per bird. The whole number of eggs laid by them during the six months from November 1st to April 30 was 42,126, an average of 76 per bird. It must be borne in mind that these birds were not selected but were the whole number of chickens reared last year."

The most radical of all methods of dry-feeding is that followed by Mr. Tillinghast, of Vernon, Conn., and he, literally, feeds his birds but once a week and waters them not at all! As to the watering, the birds go to near-by springs or a tiny brook to drink, and when the springs and brook are frozen and there is snow on the ground they eat snow for their drink.

The remarkable thing about Mr. Tillinghast's feeding method is the very few grains he feeds; the ration is almost wholly wheat screenings and beef scraps, and they are kept in hoppers, one of each in each house, and are accessible to the birds all the time. The hoppers for the wheat screenings are made from good sized boxes, shoe boxes chiefly, and will hold a bushel or more each, a supply amply sufficient for a week for the fifty or sixty birds in a house; the hoppers for the beef scraps are about eight inches square by a foot and a half high, and will hold something more than a peck each. These two hoppers of food are refilled once a week, and an ample supply is always at hand.

The very small addition made to this ration is a remarkable feature of it. In the winter time about a quart of cracked corn is thrown on the scratching litter on the floor of each house, about the middle of the afternoon, when the wagon is driven around to collect the eggs; during the summer the beef scrap is likely to become caked in his hoppers, so they will not feed down, and for that reason Mr. Tillinghast stops filling the scrap-hoppers about the first of May, and puts about a pint of beef scraps in a feed trough in each house, at time of driving around to collect the eggs. The birds have free range over the fields and orchards in which the houses are located, and in summer can get abundance of green food; in winter a supply of vegetable food, of such roots as mangolds, turnips, sugar beets, or refuse squashes, is fed out to them, and a wire-netting pocket of cut clover, dry, is hung against the wall for them to pick from—it is surprising what a quantity of this dry cut clover the birds will eat, and it seems to fill a manifest want in the balancing of the ration.

The first question that arises is as to the profits when poultry is kept on this go-as-you-please plan, and unfortunately Mr. Tillinghast does not give us figures of egg-yield to prove the profits. It will be evident that the work of feeding and caring for the flocks is reduced to the minimum; and as Mr. Tillinghast is increasing his plant and stock each year he is evidently satisfied with results. He has housing capacity for about three thousand head and last winter had about that number of birds on his place; it is his intention to increase to eight to ten thousand head and he claims that he can himself care for five thousand head of layers housed and cared for upon his plan.

We visited him in midwinter and saw some houses of pullets in which the egg collection of the day was about fifty per would feel was quite satisfactory. As illness had prevented his cent. of the number of birds in each house, a result that anyone getting out so great a number of chickens as he had intended, he was carrying over a very large proportion of old stock, and those old birds, while laying some eggs, were, as always, laying scantily. At that visit we personally went around to more than three-fourths of the houses, and saw but one bird of all the great number we inspected that gave any indication of indisposition; that bird was sneezing, which indicated a slight cold. We visited him again this summer, when the hens were molt-

ing, and of all the birds we looked over, probably over three thousand in all, saw but two that seemed out of condition, and the egg yield at that time was quite as good as could be expected in molting time; some of the pullets had even then begun to lay.

It is evident that if a ration which is nine-tenths wheat screenings supplemented in winter with a good light feed of cracked corn, will give such a good showing in general healthfulness of the flocks and egg yield in midwinter, then we who have expended a great deal of time in compounding a mixed ration and feeding three times a day have thrown away our labor and pains! The tables of analysis given in Bulletin No. 22, of the United States Department of Agriculture, show wheat screenings to have a feeding value very closely approximating to that of good, sound wheat and that wheat is the best food of all the grains is very well known.

That wheat screenings is a very economical food, there is good proof in an experiment made at the Connecticut Experiment Station last summer. Mr. Graham wished to test the Tillinghast method of housing and feeding chickens, and had built two colony houses exactly like his. In one of these houses he put 44 Rhode Island Red chickens, that were hatched April 24th, from a hundred eggs bought of a farmer living near. On June 5th two of the chickens had disappeared, probably having been caught by some animal or hawk, and the 42 chickens left, then about six weeks old, weighed 22 pounds and 12 ounces. Twenty-four of them were pullets and eighteen were cockerels; on the 29th of July the cockerels were killed and dressed for market; they averaged to weigh three and one-half pounds apiece undrawn, and sold, at the wholesale market price, for 82 cents apiece. The cost of the food for both themselves and the twenty-four pullets to that time was \$4.28 — the one hundred eggs cost five dollars, making \$9.28 as the cash outlay for the forty-two chickens at about fifteen weeks old, and there had been a cash return of \$14.76 for the cockerels sold, and the twenty-four pullets were left. On the 8th of September one of those pullets began to lay, when about four and one-half months old, and in the month of September forty-eight eggs were laid by that lot of pullets. Their food for the first two weeks was commercial chick-foods, bought of dealers in poultry supplies, and after that was wheat screenings

supplemented with what insects, worms, bugs, etc., they could pick up on range. Not an atom of meat food of any kind had been given them, no milk or other animal food, and here we find the remarkable showing of Rhode Island Red pullets reaching laying maturity at four and one-half months old on wheat screenings alone, supplemented by the animal food picked up on the range. We feel justified in calling this a *remarkable* showing!

And the grand total of results, as evidenced by the testimonials coming from many different sources, all point to an equally remarkable showing in favor of the dry-feeding method of feeding both chicks and fowls. The general health of the flocks is better than where the cooked mash was fed, the eggs are larger, stronger-bodied, more fertile and hatch out strong, vigorous chicks — chicks that are of the bound-to-live kind, and that are the delight of their owner. Here is one reported test of the fertility of winter eggs from dry-fed hens:

A Mr. Boulton, living in Connecticut, was advised by a neighbor to send to Dr. Nottage for some eggs from which to hatch early chicks, and sent him an order for a hundred eggs, in February. The following is his verbatim report upon them.

"We put yours in one tray (100 eggs) and marked them, and in the other tray put a hundred eggs from a man of a great deal of reputation, who feeds mash. I wanted to test the difference, thinking it might show in the fertility. Of your hundred, sixteen were infertile, and of his, sixty-four! I paid the same price for both, and I think the result shows well for your method of dry-feeding."

Experienced incubator operators well know that the measure of fertility is (approximately) the measure of weak germs left in the machines at the first test, and expect that about the same proportion of the eggs will fail to hatch, that there are infertile. As 64 per cent. of the eggs from the mash-fed hens were infertile, it is fair to suppose that 64 per cent. of the thirty-six eggs remaining would be weak germs and fail to hatch. That would give 23 (plus) of weak germs, and a "fair expectation" of thirteen chicks to hatch. Of the dry-fed hens' eggs, there were but 16 per cent. infertile, which would indicate but thirteen (plus) weak germs, and a "fair expectation" of eighty or eighty-one chicks to hatch. Certainly, quite a difference there!

Last summer we were visiting a large poultry farm in southern New Hampshire, and the manager called attention particularly to the bright, lively appearance of the youngsters, of which there were about 2,100 running about, some of them about half grown then. He told us that he had lost but thirty-four in all, out of that great number, and upon our expressing surprise, for there are usually a greater proportion than that which are born weak and cannot possibly survive the hardships of infancy, he told us it was a fact, and that a careful census of several of the older families had proved the correctness of the records of mortality among them.

At the Jordan Farm, Hingham, Mass., they raised several thousand chickens each year, with practically no loss from that scourge of chickenhood, "bowel trouble," and all the food for the first weeks is Cyphers' Chick Food. The result of this simple feeding method is a most gratifying growth of the youngsters, who seem to have no set-backs, and to grow "naturally," to grow from the start, without having any time lost or backward slips to make up.

The most remarkable growth of young fowls of which we have ever heard, was a pair of Barred Rock cockerels castrated, and grown to be "soft-roasters." They were killed the day they were six months old, and weighed (the pair) twenty-three pounds, live weight, and the larger one weighed ten and a half pounds, dressed. They were grown on a ready-mixed chick food for the first weeks, with cracked corn added after the first four or five weeks to increase the ration, and beef scraps. The last two months the ration was cracked corn and beef scraps, and the total result was a growth never equaled by any other method of feeding.

A New Jersey friend writes me:

"My young stock this year are simply wonders! Some of the pullets are already showing good sized combs and wattles, and from appearances, look as though they would lay by the middle of September. Some of the capons, hatched March 23d, will weigh five and one-half to six pounds now; certainly a fine testimonial to the dry-feeding method. All I have to do is to keep the hoppers filled, and they do the rest. I find I am this year raising three times as many birds as last year, with only about one-half the labor."

Let us, however, turn again to the Maine Station bulletin, and quote the statement given there. This is a State experi-

ment station bulletin, and the statement has the weight of being an official report. It says:

"The number of hens lost during the winter has been less than ever before, even when they were kept in the same style of houses. We can ascribe this to no other cause than that the birds did not overload with food at any time. We have never had so many eggs laid during the winter months by a like number of hens, but that may be due to better breeding, or to the open-front houses which the birds occupied.

"The average yield of the 550 hens during March was 20.4 eggs per bird. The whole number of eggs laid by them during the six months from November 1st to April 30th inclusive, was 42,126, an average of 76 eggs per bird. It must be borne in mind that these birds were not selected, but were the whole number of pullets reared last year."

Doesn't that have a triumphant ring to it? Isn't that a most convincing proof of the great gain of dry-feeding? That "we have never had so many eggs laid during the winter months by a like number of birds," and "the number of hens lost during the winter has been less than ever before," covers the whole range of profitable work in egg production; when we get more eggs during the winter months and fewer birds die, we may feel reasonably certain we are upon the right road, that we are making the best of success with our poultry work. Outside of the question of saving in labor and there is a decidedly great gain there, stated to be as much as a third to a half—the better growth of the youngsters, and the better health and greater egg yield of the laying stock, is ample ground for adopting the dry-feeding method of keeping poultry.

DISCUSSION.

The PRESIDENT. This is an exceedingly interesting paper on the same line as the one we have already had. Are there any further questions?

Mr. BLAKEMAN. Mr. Chairman, I have noticed that this gentleman in speaking of food which should be given to poultry says nothing about the addition of shells. Most poultrymen think that the addition of broken shells is indispensable. I want

to inquire whether that is used generally, or whether he recommends it.

Mr. HUNTER. It is used universally. It goes without saying. That is the reason it is not spoken of. Every intelligent poultryman keeps a supply of ground shells. Most of them pulverize the shells into fine bits.

Mr. WAKEMAN. May I ask one question? I do not keep a large number of poultry, but what I have, have been kept in a very convenient place on my farm near the barn. They have been there a number of years. I find I cannot keep them there any longer on account of the condition of the land. I am told that by plowing the ground once or twice it will be all right to use again. How many times will it be necessary to plow it, and how long must it be kept plowed up before it will be safe for me to use it again for the same purpose?

Mr. HUNTER. I should want to do it two or three times. If I were in your place I would move the chicks to new ground. Your chicks will do better on new ground. A thing that is worth doing at all, is worth doing well.

Mr. TILLINGHAST. Mr. Chairman, I see we have quite a number of ladies present. I wish Mr. Hunter would tell them if he knows of any ladies who are successful in raising chickens. He goes all over the country and he knows.

Mr. HUNTER. Last week I visited a farmer's wife in Maine, who keeps about five hundred head of Barred Plymouth Rocks. She is most successful. She helps her husband milk the cows, and she makes butter and all that sort of thing, but she finds time amid all her work to take care of about five hundred Barred Plymouth Rocks. She gave me some figures which I am going to publish in my paper one of these days. She makes an average of two dollars apiece on from four hundred and fifty to five hundred head. It is a better average by a good deal than from her cows.

Mr. PRESIDENT. Our program having been somewhat overcrowded this morning, Mr. McGrew's address is to come

the first thing this afternoon instead of this morning. Mr. McGrew is from Washington, D. C., and is to continue right along on this same subject.

The meeting will now stand adjourned until 2 P. M.

AFTERNOON SESSION.

December 13, 1905.

Music.

Convention called to order at 2 P. M., Vice-President Seeley in the chair.

The PRESIDENT. The address given on the program for 11:30 this morning we are to have now. We had chicken this morning, some of us had chicken for dinner and we are going to have more chicken this afternoon, and we are going to have it by a man who understands it, Mr. McGrew, of Washington, D. C.

THE REAL ORIGIN AND DEVELOPMENT OF POULTRY IN MODERN TIMES.

By MR. T. F. MCGREW, WASHINGTON, D. C.

Mr. President, and Ladies and Gentlemen:

We were told this morning that the hen comes home to roost. I love to come back to Connecticut. I was born in Ohio, and, as you know, the people of Connecticut had much to do with the early settlement of the State of Ohio. When but a lad, I was fond of poultry, and had a few chickens in a shoe box in the corner of the lot.

In 1879, with a friend, I visited the Board of Trade in the city of Indianapolis, and while there made the statement that we expected to see the poultry products of the State of Indiana ultimately far exceed the pork product of the State. The President of the Board of Trade replied that he loved to see people stand by their oars, but he said he would as much expect to see the clouds fall as to see that statement come true. Be it said, however, to the honor of the State of Indiana, that

the last census shows a greater number of dollars and cents in poultry and its products in that State than in pork.

The question was asked just as we were adjourning this morning, if we knew of any woman who had been successful in the cultivation of poultry. This same census states the fact that five millions and six hundred thousand farms reported the growing of poultry. We all are familiar with the fact that the largest amount of poultry grown upon the farms, is grown by the women, and if the lords of creation ever reach that point where they will permit every dollar which comes from poultry grown by women to go to them rather than appropriating it themselves, the next census would show seven or eight hundred millions of dollars credited to poultry grown by women. Women are most successful in the business. The Board of Trade and Commerce, of New York, credited five hundred and twenty millions of dollars last year to poultry and its products, and more than one-half of all this has been produced by the hand and physical labor of women and children throughout the country. Poultry is a product that any child over ten years of age can produce, and a product which our old grandfathers and grandmothers can indulge in to their profit.

Two conditions of poultry are observed. We discussed this morning the utility side of poultry. In dealing with the utility side of poultry, as generally spoken of, people say that it is the expectation that a hen will lay more than enough eggs to pay for its feed and keep. But that is not the whole story. Where would our Short-horn cattle, our Herefords, our Devons, and our Plymouth Rocks be if it had not been for the fanciers who follow the show-room? Fanciers whose effort has been constant all the while to increase the quality of the stock, and who have increased the quantity of the product from about twenty-five or thirty eggs to a hen thirty years ago to a point, according to the last census, of over seventy. The only difference between the utility hen that lays eggs and the show-room hen is the same difference that exists between our daughters and our wives at home doing their work and when they are dressed up to go to church. Then they are on dress parade. Poultry in the show-room must be in the finest condition in order to win prizes. Let me cite to you what I know of one Wyandotte hen, in her seventh year, a hen which has won dozens of prizes in the show room. She is a celebrated

hen. I think it was on the 16th day of last November that the hen commenced to lay again this fall, and up to the time I heard last, she had laid seventeen eggs in three weeks. Utility is the condition of the fowl for that purpose. Exhibition in the hall is another matter which simply means excellence, elegant condition and the pink of perfection so as to place them in the exhibition hall.

I have been asked to recite the history of the origin of poultry. Before going into that dry subject I wish to state this fact — perhaps I will cite a few more before I start upon that — when people, not familiar with figures, delve into them, they are very apt to go a little astray. When I asked the question this morning of the per cent. of egg yield of Mr. Tillinghast's hens, I did so in good faith. You will hear people thoughtlessly say we get ninety-four per cent. fertility from our eggs. We hear people say we get eighty and ninety per cent. egg yield from our hens. What does that mean? That does not mean that eighty of our hens lay in one day. Thirty-three and one-third per cent. egg yield in round numbers every year is one hundred and twenty eggs. Taking it by the month, and it is ten eggs per month. Sixty-six and two-thirds per cent. is two hundred and forty-five eggs per year from a hen, and with all due respect to all the records of the world, I think that all the hens that ever laid two hundred and forty-five eggs in one year could be placed in one small wagon and hauled by a pony ten miles away to market. Let us deal in facts. There is nothing in facts to be afraid of, but do not let us be misled by them. We are very apt to gain a wrong impression. People do not mean to lead you astray, but the man who says "I had ninety-four per cent. fertility" is apt to unconsciously create an erroneous idea. Now that means to him that after he had made his last test ten days before the eggs hatched, that the eggs he left in the incubator produced ninety-four per cent. of living chicks. If he only had ten eggs left in the incubator, he does not count the other ninety which have been taken out. So that when you figure it down, the extreme probability is that he does not produce to exceed twenty-five living chicks from every hundred eggs that he places in the incubator. And when I say living chicks, I mean chicks past one week old. Every single chicken that goes into the market in the United States has cost from some source or other four

eggs to produce it. I have been challenged in this statement, but I have sent letters out until I am tired, and I have received hundreds of answers from people who have kept account both of eggs hatched in an incubator and under hens, and they could not prove that they had exceeded twenty-five living chickens to every hundred eggs. That being the fact, how would it be possible for a man to have ninety-four or ninety-eight per cent. fertility. In the same way if the hens of a poultryman produced thirty-three and one-third per cent. of eggs, it would raise the average of seventy to a point where it would add almost one hundred and eighty-seven millions of dollars in one jump to the egg product of this country. Those are things that we must look at. If a man has got a hen that will lay one hundred and twenty eggs per year, and those eggs are sold in a good fair market, he can make from a dollar to a dollar and a quarter a year on that hen. That is a fact without any stretch of the imagination to lead up to it. If you have a flock of hens that are producing an average of ten each per month of egg yield, you ought to make from a dollar to a dollar and a quarter per year from every one of those hens. You ought to make that much over the cost of feeding the flock and the care of the poultry.

In the origin of poultry we have simply what might be called the theory of the naturalist. The naturalists of early days were not men of letters or men of great information. They gathered information from what they saw and recorded it as best they knew. Some of these naturalists have accepted the theory that all of the numerous families and varieties of pigeons have descended from one variety known as the Blue Rock pigeon, so plentiful throughout many of the continental countries. We are told that our chickens have descended from one *Gallus Bankiva*, or the Jungle Fowl of India. Following that original statement comes the discovery of the naturalist who found another jungle fowl which he named *Sonnerati*. We are taught by these early naturalists that these two were the original ancestors, from which have descended our poultry. Naturalists again tell us that the most immense animal in the world was that species of elephant called the Mammoth. Later they discovered the great Lizard, and within a few months the naturalists of the Museum of Natural History in New York have discovered one very much larger than any

of the others, so that they had to call it Rex, in order to get a name superior to those which they have already described.

We might accept the theory that the Jungle Fowl of India was the ancestor of all our games and game bantams, but I would ask the scientist and the naturalist, and I would appeal to you if you can believe that the mammoth fowls of China, the Shanghai, the Brahma, and Cochin could have descended from those little miniature birds known as the Jungle Fowl. I think that other sources must be looked for beyond all this to tell us the truth of whence they came. Perhaps I have been led a little astray from the pathway of the naturalist, from the fact that a friend of mine visited China some twenty years ago, in company with a good Catholic father, who was in a position to have great insight into the buildings and homes of the Chinese people of a class much like our Jesuits here. They call them their retreats. In these retreats are a lot of people and their descendants who have lived there for ages on the borders of the Chinese Empire. These people have records which this old father of the church found out, went so far back beyond anything that he knew of, or that was recorded in the Bible, or by the church, that he said he was afraid that if it became published to the world it might upset the Christian religion. In these records, the part that I was interested in, and my friend as well, was recorded the fact that four thousand years at least before the beginning of the Christian era, these people had these retreats; and kept some of the large sizes of Chinese poultry. The record shows that they had been cultivated, and that the hatching of such fowls had been in practice. The eggs from such poultry had been sold, and the young chicks hatched and sold four thousand years before the Christian era. In our own Bible we have it recorded that when that Good Man upon earth was deserted by his nearest friends the cock crew thrice. If there had not been some such variety of fowls at that time they would not have been domesticated so as to have been near enough to the pathway of the Master to have crowed so early in the morning. Some thirty-five years after the crucifixion, three separate varieties are mentioned in Roman history. In Pompeii they dug up a flagon, on one side of which was engraved a beautiful game cock, and on the other was a pea fowl, showing that these two were known in their beauty and elegance. Now with all this in-

formation that has come to us, cannot we realize and be ready to accept the idea of a more extended creation originally than the one little Jungle Fowl?

Another matter that has interested me very much, and which carries us back, is the intimation made by the members of the American Legation in China during the troubles there, that the records show that the Chinese people had discovered America centuries before Christopher Columbus was heard of. Why not, if these people came here to settle in the far north, is there not enough similarity of appearance between the Eskimo and the Chinese to lead us to such a conviction? The ancient history of China goes back beyond anything that has ever been recorded by the ancient Hebrew or anyone else. Those records are undoubtedly authentic. Taking the method and their manner of keeping the records, it is said to convince every one who has come in contact with them of their truthfulness. This being the fact, and it being found in the recorded history of this brotherhood that they kept poultry of this mammoth size, it leads me to believe that long before there was anything known of the Jungle Fowl in India, there was some other fowl from which those large Chinese fowls descended. Now in proof of this, let me make this statement: All poultrymen know of the Malay Game, a mammoth game fowl. It is a question, according to the ancient records of India, whether the Malay or Kulm fowl was the first. It may be somewhat unimportant whether the Malay was first or the Kulm fowl was first. That cannot be decided. They do know, however, that the Kulm fowl and the Chinese Shanghai were very similar. From what origin came the great Shanghais and Brahmas and Langshans? Some of the original of all these, like the Kulm fowl, had no feathering whatever upon the shanks, while others showed the development of the shank and toe feathering to a slight extent when they came to us from China. The plastic condition of the conformation and changes has been cited from the fact that Bantams can be created almost at will. Nature has willed it almost to an absolute certainty that the largest per cent. of influence as to size and character rests with the female. The making of Bantams is accomplished through the selection of the very smallest of females, and pairing them with the smallest males possible to obtain; through the breeding of two generations in the one twelvemonth, and curtailing the size through

the hatching at the beginning of winter and rearing during the cold months without much care and protection. As an example of this, the writer, within the space of six years, reduced through nine generations Dark Brahmas to Dark Brahma Bantams that were shown within the standard weight. These were all built up or created through the selection of the smallest females and then reduced in size under the influence of rearing the young during the winter months. This entire family was disposed of, and within four years from the time of their passing into other hands, we scarcely think there can be one descendant found from that family that could go into the showroom at maturity and weigh in under standard weight. The dwarfing through unnatural methods does not prove anything for or against the early or original creation of the ancestors.

Many years ago the breeders of Leghorns said their fowls were too small, and they introduced the Minorca blood. Soon they began to learn to use only hens in their second year, and the largest they could get, and thus they began to increase gradually the size of the fowls. As you increase the size of the bird you increase the size of the egg.

Following along in recent or modern history of poultry, the first great event in this country was the production of the Light Brahma. Following this came the Leghorns, a breed which came into the possession of a gentleman of White Plains, N. Y., from a vessel lying at anchor in New York harbor; when they came he recorded the fact that these White Leghorns had white shanks and beaks. That fact led many of us to believe that the original Leghorn was a White Minorca. All of the European poultry, the Polands, the Hamburgs, and the Leghorns, are the producers of white shelled eggs. Every bit of poultry that we have that is in any way tainted with Asiatic blood, produces eggs having a brown shell. If you will remember that distinction, you will find that in European poultry, Polish, Hamburgs, Leghorns, and Minorcas, all of these produce eggs with a white shell. On the other hand, the Asiatic family, including the Langshans, Malays, Cochins, and the Brahmas, all belong to the class of fowls that produce brown shelled eggs. When you intermingle either of these you never get aught but a tinted colored shell. There is no blood so strong in the whole poultry fraternity as the blood of the Asiatic fowl. Our Plymouth Rocks, Wyandottes, and the

Orpington varieties of England, are all influenced by the superior power of the Asiatic blood. Every one of these produces a brown shelled egg. You cannot bring together two separate breeds or varieties of poultry and intermingle the blood without changing three things, the form, size and shape of the egg. Whenever you produce a cross from pairing together any two breeds you have interfered with the regular line of product, and therefrom come the countless numbers of ill-formed and misshapen eggs. Mr. Tillinghast told you that he preferred the White Leghorns because the White Leghorn egg went into the New York market at the highest price. It is a white shelled egg. Why does the white shelled egg go into the New York market at the highest price? Because they are all white and all of regular size. Nothing but European fowls will produce such eggs. You cannot violate the laws of nature to any great extent in crossing without showing the effect upon the egg. By the time you have influenced size and form, you will find you can get neither the clear brown nor the clear white egg. It is the clear, bright, white-looking egg that the New York market wants. If there is anything in the world that caters to the taste of the New Yorker, it is appearance. There is no place in the world where so much stress is laid upon appearance as in New York and they want these beautiful white shelled eggs. But you can leave New York in the morning, after having had white shelled eggs for breakfast, and go from there to Boston, and there everything is brown. You could not hire them to introduce anything else but the brown shell. If people would be as particular in taking care of their poultry as they are to get the doctor for the horse, when he is sick, they would succeed better in the business.

Mixed hens lay mixed eggs, and when you go into the market with them, you get from sixteen to nineteen cents a dozen, while Brother Tillinghast may go into the market and find plenty to take his at forty-two cents. What is the meaning of that? He keeps his Leghorns pure. He can get forty-two cents a dozen for the best white shelled breakfast eggs, and these other mixed eggs sell at from sixteen to nineteen cents in any commission house down-town. Suppose you have five hundred mixed hens. My advice is to go home and sell those five hundred mixed hens in the market for what you can get for them. As far as possible handle only pure bred fowls

of some variety. If anybody tries to induce you to cross your stock, chase him off the place. If you have a variety of hens that lay nice, clean, fine-shaped, brown shelled eggs, you can sell them even in the New York market for forty cents. Do not put mixed eggs into the market if you wish to get the best price. These are facts. These are things that people should stop to consider. If you could put into the market from the State of Connecticut every single egg that will be produced this winter, and get forty-two cents instead of sixteen to nineteen cents for off-colored and ill-shapen eggs, you would have about two hundred and fifty thousand dollars coming into this State for eggs, simply because you did not allow somebody to come along and try to persuade you that their idea of cross breeding is better than pure bred poultry. When you see a man that is getting nineteen cents a dozen, just think of Brother Tillinghast, and think how nice he is fixed down there at his home with his forty-two cent eggs. It is just as easy for you all to have forty-two cent eggs, for there never will be a time as long as this country increases in population as it does when there will not be a market for such eggs, and there will never be, I am afraid, more than enough to supply the people of the city of New York alone.

Now I do not wish to tire you, but I must mention one or two facts more. I want to help you to do better because nothing makes people feel happier than a nice little cash balance in the bank. Then they can look every man in the face, and say, "I do not owe you a cent." I have visited the markets of New York, Boston, Washington, Philadelphia, Baltimore, Kansas City, Chicago, Dallas, Texas, and St. Louis, and I do not think there is a city of over one hundred thousand inhabitants where I have not gone among the poultrymen and inquired as to the price of eggs and dressed poultry and I find this very same condition in most all of them. Dressed poultry is selling from seven, nine, twelve, fourteen, sixteen to twenty cents a pound, and if you want something nice out of the ice-box, you must pay about thirty cents. Now what are the facts about that situation? The man that sold that thirty cent poultry made money; was doing well. The fellow that sold the seven and nine cent poultry probably has a mortgage on his place and never will be able to lift it.

I received a letter from a lady in New York, who said to me:

"I have two little children to support, and I want to sell my eggs in the New York market." I went down to a gentleman whom I knew, told him about the matter, and he said, "Why certainly, I will take all she has to sell." She shipped them in, and he immediately telegraphed her not to send any more. I telegraphed her to come to New York. She came, and I took her to the store. That man paid her five dollars to stand in his store for two days and try to sell her own eggs. It taught her a lesson. She went back home, and for five years she has never been paid less than thirty cents a dozen for her eggs in that store every single week in the year, summer and winter. She learned the lesson that every one must learn in the future who expects to successfully run a farm, and that is, if you sell at the bottom price you are going to be bankrupt; if you sell at the top price, you are going to make money.

There is another thing that I want to talk to you about, and that is the agricultural interests of the United States. Five million and nearly six hundred thousand farms are reported as growing poultry, in the last census of the United States. That proves conclusively that we have five million six hundred thousand farmers not only interested in agriculture but interested in poultry. It is safe to say that each one of those farms represents or supports five people, making a little over thirty millions of the population of the United States that we know are farmers or dependent upon the farms. If those thirty million of people go with a load of potatoes or a load of corn, or a load of water-melons, or with a basket of eggs to market to sell they have got to deliver to the people to whom they offer those goods, the identical article that they are selling. Perchance, some of the good ladies here have gone to market with their farm produce, and they desire to return home and make some lovely mince pies, such as my grandmother used to make and serve when I was a child. I want to ask them if they believe that the people to whom they present their products for trade will be as particular in returning a good quality of cinnamon, cloves, allspice, ginger, or whatever they wish to use at home, as they are to get good products from you? How do you know when you trade your wagon-load of potatoes, in part, for a few

pounds of pepper, that you do not carry up to your home finely ground hulls of buckwheat flavored with capsicum? It is due to the farming interest of the world that every man, woman, and child shall rise in his might, over the length and breadth of this great country and say we demand at the hands of our government a law that will return to us pure food products in exchange for the products that we grow upon the farms by the sweat of our brows and bring them in exchange for barter.

I have but a few minutes more to stay, but if any one has a question to ask, I would be glad to have you ask it. Before you do so, however, I want to say one more word. The backbone of the American government is the agricultural people, from Maine to California, and from Alaska to the Gulf. You are the people that own the country. You are the people that can govern. You are the only people that can say to the legislature of the national government, we demand our rights; we demand that the people that have gone ahead and practiced this outrage upon our stomachs, our homes, our families, by selling impure articles of food, shall be compelled to brand upon the product that they sell us, the honest contents of the package. How many of us, when we buy canned goods, ground coffee, a package of tea, or cinnamon, cloves, allspice, or any of these things know what we get and what we pay for? Now if you people will look facts in the face and act together as the saying is, you can be the power that will rule the world, so far as America is concerned, and you can have whatever is your right, if you will only unite and say we are the people, and we wish the true return that is our due.

Now if there is any question that anyone would like to ask before I go, I would be glad to answer it. Before I go I want to thank you for your kind attention.

Secretary BROWN. At this point I would like to offer the following resolution:

“WHEREAS, the agricultural experiment stations are found to be of the greatest aid to the farming interests of this State, and

WHEREAS, the Hon. H. C. Adams, Congressman from Wisconsin, has introduced a bill, H. R. 345, providing for increased federal appropriations for these experiment stations,

RESOLVED, that the Connecticut State Board of Agriculture in annual convention assembled, endorses this step in agricultural progress with most hearty approval, and

RESOLVED, further, that the Secretary be instructed to transmit copies of this endorsement to the several Senators and Representatives from this State, together with a respectful and urgent request that they lend this bill their earnest and favorable support."

Mr. STIMSON. May I say just a word in that connection? The finest champion in Congress today, of modern progressive agriculture, is the Hon. H. C. Adams, of Wisconsin. He is aggressive, he is full of modern agricultural ideas. For several years, in the face of big odds, he has struggled in the committee to secure the passage of a bill providing for an increased appropriation for the different States for the benefit of the experiment stations located within them. Several times he has been very close to getting the bill through. This year if we all work together with this best friend of ours who has appeared in recent years, we believe that the bill will pass. The bill is unqualifiedly endorsed by the National Association of Agricultural Colleges and Experiment Stations, and by the presidents of the colleges. The bill has no string to it whatever. A string in previous years has been put on. For instance, a string of this sort has been put on, providing that some one may say how the funds shall be used in the different States. The bill as it stands today is without a string of any kind. We in Connecticut will be at liberty to say what this money shall be used for. The experiment stations in Connecticut are investigating some of the present problems of agriculture and problems that are going to demand attention, and the stations are becoming very much pressed for funds to do this work.

Mr. Tillinghast said this morning that he had no records of his egg yield over a month or two that he wanted to make public. We have an experiment in progress at the College by which we are testing Mr. Tillinghast's method and keeping

careful account of it. Now it is cheaper to make a mistake in one place than it is to make a mistake in four or five hundred or a thousand places. It is cheaper to demonstrate to your satisfaction the best method of success in one place than to make people attempt to attain such success in many. We, at the experiment station, want to help you poultrymen. We want to do four times as much as we are now able to do. We want to do four times as much for the dairymen of this State, and for the fruit growers, as we now do. The appropriation that the federal government will provide, if this bill passes, will not increase our capacity four fold, but it will increase it two fold. This resolution puts upon the Secretary of the Board of Agriculture a duty. If you pass it he will transmit the will of the Board of Agriculture to our several Senators and Representatives. I hope, however, he will not stop there. I said in the beginning that farming needs friends. How? Last winter when we wanted a dormitory at the Agricultural College, you went up to Hartford on that day when the matter was under discussion before the legislature, and you filled the hall of the House of Representatives. You said we need a good house for our boys to live in so that they can get an agricultural education, and you got the building. Now buy two postal cards, or one postal and a two-cent envelope, and by spending ten minutes' time you can show your interest as a friend in this movement for the advancement of agriculture in Connecticut and in the country, and at large. Let every man here, I do not care how many women — the more the better — write to every man of our Representatives and Senators from Connecticut. Write to your Representatives and Senators this: "Please send me a copy of the Adams bill." Do not forget it. Or you can go a little further, "Please send me a copy of the Adams bill asking for an increased appropriation for experiment stations." When you get it read it through. The friends of agriculture only ask that these measures shall be passed on their merits. Read the bill. If you think it stands for what you want it to

stand for, then please write a letter to each one of the Senators and Representatives from Connecticut in Congress, and say, "I am familiar with that bill. As I know the needs of agriculture in Connecticut, and as a favor to me, as a Connecticut citizen, and to the people of my township, whose sentiments I know in regard to it, will you please lend your efforts to the passage of this measure?" Let us work together. The bane of farming in the past has been incredulity and divided endeavor. In union there is strength. (Applause.)

The PRESIDENT. Any further remarks? Are you ready for the question? All in favor of passing these resolutions signify by saying "Aye." Contrary minds, "No." It is unanimously passed.

We must now go on with the program. Professor Thomas Shaw, of St. Anthony's Park, St. Paul, Minn., will now give us a paper on "Breeding Animals on the Farm." I have the honor of introducing Professor Shaw to you now.

BREEDING ANIMALS ON THE FARM.

BY PROF. THOMAS SHAW, ST. ANTHONY'S PARK,
ST. PAUL, MINN.

Mr. Chairman, and Ladies and Gentlemen:

Before leaving home to visit New England, one of my friends was good enough a short time before I left to call my attention to an article in one of the St. Paul papers. It referred to the subject of abandoned farms in New England. He wanted to know why I was going down to New England, the country of abandoned farms, to talk to the people on agriculture. The next morning I happened to get hold of a copy of the census report on agriculture in the United States. He aroused my curiosity a little bit, and I wanted to know a little more about that country of abandoned farms, so I looked up the question in regard to the production of corn, and I found that the average production of corn per acre in the six New England States for the ten years ending in 1899 was thirty-five bushels per acre. I then turned to the report regarding the production of corn in seven States of the corn belt of the

West, and I found that the average yield per acre in those seven States for the same time was twenty-nine and a fraction bushels per acre. Then I sat down and wrote an editorial for the *Orange Judd Farmer*, and wound it up by saying that I would recommend to the people of the corn States to send on a delegation of thorough farmers to New England to find out how to grow corn. So I came to New England to talk on agriculture, or to attempt to talk on agriculture. I know, fellow-farmers, it is a bold undertaking. I know it better than some of you know it, if you have never tried it. To go to a country in which you never have set foot before, and to look into the faces of an intelligent audience, and to talk to them on the agriculture of their country — I tell you, farmers, it takes a little nerve. But I may tell you that I am delighted to be able to say that while I never took much stock in that question of abandoned farms, I take less than ever I did before I came to New England. Now I want you to understand that this abandoned farm business is something serious. It is hurting you people. It is hurting your reputation, and it is hurting you unjustly, as I am glad to find, and I want to have you understand that the people of the West are not responsible for those views which they hold in regard to your country. It is due to the pamphlet and magazine articles that are printed somewhere in the West, but not in the East, sensational in character, and they find their way into our periodicals, and these are the sources of information from which the people of the West form their opinion in regard to what is going on in New England. But fellow-farmers, really some of our Western men think New England and New England agriculture is going to the dogs; that there is no hope for New England farming. But, Mr. Chairman, I have not heard, sir, a single note in a minor key in regard to agriculture since coming to this State; there is hope in the sound of your rivers that run down from the mountains towards the sea; there is hope in New England everywhere; there is more hope in the intelligence of the men that till your lands. One can see it in the faces of New England farmers, such as those I am looking upon today. But fellow-farmers, I did not come to New England to talk to you simply about the hope of New England farming. I came to talk to you about a very different subject. I came to talk to you about what the students call "hardtack,"

if I may use the phrase. I do not think it is very far wrong. I came down here from Minnesota, more than a thousand miles, to talk to you, farmers, about the subject of animal breeding. I want to tell you right here, lest you should be disappointed, that I did not come to tell you anything that you do not know. You may say that is strange. You may say, "You come a thousand miles to tell us what we know already?" Right. Let me ask you — did you go to church last Sunday? What did you go for? Did you go with the idea that the man who stood up and faced you and talked to you about the higher things of life was to tell you something new? No, you did not go for that purpose at all. You just went for the purpose of keeping in remembrance and refreshing your memory upon what you did know. I came to New England, not in the hope of telling you anything new, but with the hope of putting your memory in such a condition about some of these things that you will go out and try to do some of the things I believe you should. I shall look upon my mission as a failure if these things which I shall now attempt to give you on the subject of animal breeding are not of value. I would like to know, fellow-farmers, how many times you have listened to this kind of discussion from the institute platform. I do not know whether you discuss the question of animal breeding much in New England or not, but I do know that they do not talk about it very much from the platform in the West. I sometimes think it is because of the complexity of the question. In some respects the art of breeding is like a great hole in which an intellectual giant may sink a thousand fathoms and more at the very first plunge. In other respects it is a broad shallow, in which a child intellectually may wade without any difficulty. In some respects the operation of its laws is so regular and plastic that the skilled breeder may almost mold and fashion at will. In other respects they are so erratic and subtle as to confound the most skillful, the results are so different from what he expected. The great differences thus resulting in some instances from even skillful breeding are doubtless the outcome of laws that are apparently antagonistic, but not really so. They are only apparently so because they are not yet sufficiently understood. It may be that they never will be, but, happily for the breeder, the results from the proper application of principles, that are now well understood,

are so regular and uniform, that the man who diligently applies them will, with unfailing certainty, so improve the average of the animals in his stud, herd or flock, that they will be brought to a higher level.

The known laws that govern breeding are three in number. They are known respectively as the law that like produces like, the law of variation and the law of atavism. The first and second of these laws are apparently antagonistic. The third, like a pendulum in operation, swings between the two.

The law that like produces like, means that the progeny shall be like the parents, not an exact facsimile, for two parents are never found exactly alike, but in all essential features there will be a close resemblance. This resemblance will, with more or less of uniformity, extend to the physical form, to function, to habit, to disposition, and indeed to every feature of the organization. This law is the great Magna Charta of the breeder. The results from the operation of this law are by no means uniform. They will be nearly so, however, in proportion as the parents have been purely bred, in proportion as they have been bred in line without having reached the danger point of weakened stamina, and in proportion as the parents are strong and vigorous.

The law of variation, or the law that like does not always produce like, is apparently antagonistic to the law of likeness. It means that the progeny shall not always be like the parents. Though apparently antagonistic to the first law, it may be simply a part of the same, the differences being the result of modifying factors in transmission as yet not well understood, and until understood, beyond the control of man. In breeding pure blood animals, these differences are not usually very well marked, though they are constantly present. Sometimes they are very great, as when, for instance, the progeny of horned parents are hornless, but such variations are of infrequent occurrence. Some have claimed that in transmission, variations are more constant and greater than resemblances, in other words, the second law of breeding operates more strongly than the first law. In breeding pure bred animals, this is not true. If it were so, the breeder would be on an uncertain sea; without sail or rudder. The only improvement that he could make would be through selection.

The presence of the law of variation is by no means inherently adverse to improvement in breeding. The result depends first, on the character of the variation, and second, on the disposition made of the animals which thus vary. Variations are sometimes downward, in other instances they are upward. When downward, the animals should be eliminated. When upward, they should be retained for breeding. Were it not for variations in the direction of improvement, advance in breeding would be impossible. Viewed from this standpoint, the law of variation is a blessing rather than the thorn which it sometimes proves to be.

The law of atavism is the law which, in transmission, determines that the progeny shall be like some remote ancestor. It is probably a branch of the first law of breeding acting in an erratic way. Like the law of variation, it is a disturbing factor in breeding. But it is more disturbing than the former, in that it introduces variations that are undesirable. It resurrects from out the dead past what the breeders have been trying to eliminate. The frequent occurrence of a white calf in the breeding of Shorthorns which the breeders have been trying to avoid for generations, illustrates the disturbing character of this law. It may be that its existence is intended to compel the breeder to give careful attention to purity in blood lines, since its power wanes in proportion to the increase in the duration of the period covered by pure breeding.

Having thus briefly outlined these laws, the effort will be made to enlarge on some feature of their practical application to the operations of the breeder, and also of every farmer who breeds even one animal on his farm. The points that will be more particularly dwelt upon are those which relate to the evidence of prepotency in sires, to the improvement of livestock through upgrading, and to the futility of promiscuous breeding in so far as it relates to the improvement of live stock.

Prepotency means the power possessed by a parent to transmit individual and breed properties to the progeny. The measure of its strength, however, is more evidenced in the former than the latter. Thus it is that prepotent sires produce uniformity in the stud, herd, or flock. The uniformity thus produced is proportionate to the prepotency of the sire and the excellence of the uniformity is at least measurably propor-

tionate to the excellence of the individuality in the sire. The importance, therefore, of possessing good and prepotent sires cannot easily be overestimated. The truth that the sire is half the herd is only a half truth. He is as much more than half the herd as his prepotency exceeds that of each female parent in the same.

But how may it be known that a sire is prepotent before his prepotency has been actually proved, as evidenced in the offspring. The answer to this question is of all absorbing interest to the breeder, for sires are usually chosen before they have begotten progeny. This raises the question as to the probable guarantee of prepotency. These include purity of breeding; line breeding in degree and individual vigor.

Other things being equal, a sire is prepotent in proportion to the duration of the time that he has been bred pure. This result follows from the continuous increase in the dominant blood elements with increase in duration in breeding without the introduction of alien blood. Whether there is a time limit to this increase is as yet an unsettled question. In other words, it is not yet certain that an animal from an ancestry bred pure for a thousand years will be appreciably more prepotent than an animal bred from an ancestry kept equally pure for five hundred years. These dominant blood elements having become thus fixed and stable, are transmitted with at least reasonable certainty to the progeny.

Other things being equal, a sire is usually prepotent in proportion as he is line bred or otherwise. Line bred means bred within the limits of one family for at least several generations. The closer the relationship at the outset of the line breeding and the longer the duration of such breeding, the more prepotent the sire is likely to be. For instance, suppose a Shorthorn sire is chosen from the Missie family of Cruikshank Shorthorns. If the said sire is chosen amid progeny bred for generations from Missie sires and dams, no other Shorthorn blood meanwhile having been introduced, the line is likely to be more prepotent than if drawn from progeny whose ancestry included members of various families of Chuikshank Shorthorns.

Other things being equal, prepotency is strong in proportion as the sire is possessed of inherent vigor. This is in keeping with that other observed fact, that usually prepotency is stronger in an animal when at that age in which bodily vigor

is greatest, rather than at an earlier or a later period in its life. The evidences of bodily vigor are form and action. The latter is usually spoken of as carriage, and, as an evidence of prepotency, it is probably some more important than bodily form. The evidences of bodily vigor are such as relate to strength and vigor for the breed. The most prominent of these, probably, is not chest size so much as chest capacity. Vigor in action may be nicely illustrated by observing the carriage of a Southdown male. The vigorous male steps quickly. He carries his head proudly. His full eye observes everything. The slightest sound causes him to prick up his ears. Such a male purely bred, is almost certain to be prepotent.

But what is meant by other things being equal? Simply this, that with each of the indications mentioned, the other indications shall be present in at least fair degree, and that the parents and progeny shall both be sustained with suitable food, fed in liberal but not in excessive supply. For instance, long purity of breeding will count far more if linked with line breeding and bodily vigor, and so of each of the other indications, and all these will be more potent when the feeding and management are favorable to high development.

In addition to the indications mentioned, the performance of the immediate ancestors for several generations should be carefully noted. By performances is meant what the animals have done in speed attainment, milk, meat or wool production, according to the end for which they are kept. Nor should the fact be lost sight of, that high performance in the ancestry is valuable as it is near, and less valuable as it is remote. High performance in the immediate parent of a sire is of great value, but high performance in an ancestor of ten generations in the upward line of ascent is of but little account. This will be readily apparent when it is remembered that the blood properties of an ancestor of ten generations, previously, are only present in an infinitesimal degree.

The claim, therefore, that an animal traces to some famous ancestor of many generations back, is of but little account. It can only deceive those who do not know. Excellence in performance in the near ancestry is not only valuable, but it is valuable in proportion as it is uniform in the near ancestry and far reaching in its comprehensiveness. By uniformity is meant evenness of performance in all the near generations, and by

comprehensiveness, the extent to which various desired qualities are present.

By upgrading is meant the improvement of common stocks through the use of successive sires chosen from one and the same pure breed. For instance, when common females, it may be of mixed breeding, are mated with a pure bred Holstein sire, and when the female progeny continue to be thus mated in succeeding generations, the produce are termed grade Holsteins, and when this line of breeding is continued for several generations they are termed high-grade Holsteins. When good and prepotent sires are chosen, it is, in a sense, wonderful how quickly common stocks will be improved, providing the food given is suitable, and the care of the animals is proper.

When the process begins, mixed blood elements in the females is no detriment. It does not stand in the way of quick improvement. In fact, the reverse may be true, since every additional blood element lessens prepotency in the female. In other words, the less purely bred she is, the less the power that she will have to transmit her own properties. Consequently, when mated with a purely bred prepotent sire, the preponderance of resemblance in the progeny is to the sire. The preponderance in all essential properties will come from him also, and in both instances because of his superior prepotency.

Analyze further this upgrading process. Suppose the foundation female is a ewe secured from the range and that she is possessed of the blood elements of a dozen different breeds. She is mated with a prepotent Southdown male. Let the difference in blood elements or properties between the two at the outset be represented by one hundred. The first thought would be that fifty per cent. of the properties or elements in the progeny would be inherited from the dam and the same from the sire. That is not true. More than fifty per cent. of those properties come from the sire, as many more as the prepotency of the sire, in virtue of his purity of breeding, exceeds that of the dam. Less than fifty per cent. of those properties come from the dam, as many less as her prepotency or power to transmit her properties is less than that of the sire, as a result of her mixed breeding. The preponderance in properties in the progeny inherited from the sire will exceed those inherited from the dam, as much as the power of the sire to transmit his own properties because of his strong prepotency,

exceeds that of the dam to transmit hers, because of her weak prepotency. This explains why in the first instance of such mating, the progeny bear so strong a resemblance to the sire.

The difference in blood elements at the first, as previously stated, may be represented by one hundred. Now, since the progeny inherits far more largely in such breeding from the sire, the difference in those blood elements will have been reduced more than fifty per cent. So far as the sire is concerned, the progeny will be possessed of far more than fifty per cent. of inherited properties from him. The exact per cent. represented by such inheritance cannot be exactly stated, but it would be approximately correct to say that seventy-five per cent. of properties in the progeny were inherited from the sire, which would leave twenty-five per cent. of the same to be inherited from the dam. Thus a great stride has been made in the very first mating. The difference in blood elements now between the Southdown sire and progeny will be represented by twenty-five instead of one hundred, as at the first.

Mate with a Southdown male again and the progeny of the second generation will be possessed of approximately ninety per cent. of Southdown properties; of the third generation of approximately ninety-seven per cent., and of the fourth generation, of approximately ninety-nine per cent. The progeny of the fifth generation will, in individuality and useful properties, be practically equal to pure bred Southdowns. This wonderful transformation may be accomplished in five generations of such breeding. In other words, the entire common stocks of farm animals in the United States could be transformed within the time named into pure breds, that is, into animals as good as pure breds, for practical uses. At the present time, however, the supply of pure bred sires would be far too little to accomplish such an end within the time.

Suppose that instead of pure Southdowns, grade Southdown sires had been used. If the prepotency of those sires in each instance exceeded that of the dams with which they were mated, then there would be improvement. The improvement would be proportionate to the excess of that prepotency. But even on the supposition that the prepotency of each Southdown male was superior, variable elements would probably appear in the progeny as the outcome of these elements in the sires, and these would in some instances, at least, make improvements

slower, while such sires were used, the level of improvement reached would never equal that made in the former instance, and improvement would be made very much more slowly. The advantage, therefore, and profit, from using only pure bred sires is clearly apparent when these can be secured without excessive cost.

Suppose again, that the Southdown sires had been inferior individually, though purely bred, what would have happened? Why, because of their prepotency the result of the purity of their breeding, they would sustain their own individual superiority in the progeny. This might not have followed in some instances because of the influence of atavic transmission, resulting in bequeathing properties to the progeny possessed by superior ancestors. As a rule, however, the transmission would more or less resemble the inferiority possessed by the sire. The breeders of grades are usually content with a very common or inferior pure bred, because of the cheaper cost, but to invest in such is clearly a mistake. The place for all these inferior sires is the block in the case of meat-making animals, and in the dray or van in the case of horses. The breeder who chooses sires thus, makes a grievous mistake. An inferior sire is *dear* at any price. He is dear as a gift. The extent to which such sires have been used by the breeders of grades has greatly retarded live stock improvement.

The view so widely held that while the progeny of the first mating are a great improvement on the females from which they are bred, the progeny of the second mating and also of succeeding generations, is likely to be inferior, is a fallacy. In up-grading, such a result would be clearly impossible. The improvement will be continuous until the level of the breed is reached from which the sires are chosen. It is in cross-breeding that such results sometimes follow, that is, when sire and dam are mated each strong in the blood elements of a different pure breed. In such instances, usually but not always, the progeny is at least the equal of the sire or dam in useful properties, but not in prepotency. The improvement is probably the result of the renovating influence that would seem to inhere more or less in introduced alien blood. In succeeding generations, however, there may be a tendency to revert to one or the other of the two breeds thus mated, thus leading to uncertainty in the results and sometimes to retrogression.

What may be termed promiscuous breeding is the style of breeding most commonly practiced. The average farmer chooses a sire from a certain breed, it may be on the ground of convenience or because the breed for the time being is popular. Soon another breed becomes popular, and a sire is chosen from that breed. It may be that in a lifetime sires have been used from half a dozen breeds.

Now see what this means. Suppose, for instance, a pure Jersey sire is mated with a grade female of breeding that is much mixed, far more than fifty per cent. of properties in the progeny will be inherited from the Jersey. Suppose that now a pure Holstein sire is used in mating with the females thus begotten, the progeny will possess more than fifty per cent. of Holstein properties, but the Jersey properties will be proportionately eliminated. Suppose again that pure Shorthorn sires are chosen to mate with the grade Holstein females, then more than fifty per cent. of the properties will be Shorthorn, the Holstein properties will be proportionately reduced and the Jersey properties will be still further eliminated. Those who breed thus are like the man who, as often as he walks up the hill, walks down again, or like him who sails continuously in a circle. At the end of a lifetime of such breeding, the breeder will find himself just where he was when he started.

Upgrading is the true system of improving live stock. Cross-breeding, that is, the mating of two distinct breeds, should have but little place in the operations of the farmer. It may be advantageous in some instances, as when the dams and their progeny are to go to the block. It may be profitable, for instance, to cross aged Merino ewes with males of some better mutton breed, and to prepare both for the market by fattening them on rich pastures, but ordinarily such crossing should stop with the first cross. To carry it further would, probably, for a time at least, introduce elements of reversion.

But, it may be asked, are there no instances in which alien blood may be introduced with animals that have been upgraded? There are such instances, as when the animal thus graded have partially lost some useful property or properties. It is possible to restore those properties or at least to improve them greatly in some instances by the introduction of an outcross, that is, by making one cross from sires of another breed.

This may be illustrated in the condition of many of the high-grade herds of Poland Chinas in the corn belt at the present time. Many of these have too little bone, too little stamina and weakened breeding properties. One cross from sires of either the large Yorkshire or Tamworth breeds would lead to wonderful improvement along those lines. The breeders could then fall back again upon Poland China blood if they desired to do so. Such teaching may sound like rank heresy to some, but that it rests on a sound basis, will be found by all who put it to the test.

The way to improving the average stocks of the country is therefore so plain that any can understand. It is so entirely feasible that all may practice it and it is so inexpensive comparatively that every one may adopt it. But the thought should ever be present, that in all upgrading the food must be adapted to the needs of the animals, otherwise the improvement sought will be hindered in proportion as such adaptation is lacking.

Now I do not know whether I have been talking to you, farmers, in regard to anything you wanted to hear or not, or about what will help you. I think I better find out, so I think I better stop right here. I hope I am not through yet, but I want the audience to do the rest. I forgot to say to you right at the beginning, to think about this question, and if there are any of the points in regard to this that are not clear to you, be prepared to ask questions. Let your questions come in like a shower. I do hope that you farmers will have a lot of questions to ask in regard to this important matter. I do not think there is a more important matter relating to your work, or to those who are engaged in the breeding of live stock, than this very thing we are talking about this afternoon. Now let us have your questions.

MR. MANCHESTER. I would like to ask the gentleman this: We are breeding cattle and have been using pure bred Jersey sires for the last twenty years. According to the theory you are going on, our stock ought to be greatly improved. It has been improved, but not over three out of five are any improvement over the dam. Why is that so?

Prof. SHAW. You say not over three out of five?

Mr. MANCHESTER. Not more than three out of five show any improvement on the dam.

Prof. SHAW. You remember that we have been talking about the law of variation. Now I suppose that explains it. I hope that you are not going to tell me that your herd now is not a pure bred herd, if you have been choosing pure bred sires for twenty years. I hope you are not going to claim that your herd is not as good as though they were pure bred, I hope you will not say that.

Mr. MANCHESTER. I could pick out a great deal better pure bred herd.

Prof. SHAW. Of course, you know that breeding alone will not do it. There must be careful selection.

Mr. MANCHESTER. If that theory of yours is correct, why are not all of them an improvement on the dam?

Prof. SHAW. Because of the operation of the law of variation. A man may be breeding from pure bred sires, and that man may be breeding in the very best possible manner, and yet probably one out of every three will not be as good. The principal thing for a man to do in breeding that kind of stock is to turn it off and save the best. There must be a constant selection along with the improvement in breeding.

QUESTION. What is the cause of the law?

Prof. SHAW. I could tell you better if I understood how those animals were cared for.

QUESTION. Is there any danger in using a thoroughbred sire after keeping him one or two years that he may not be prepotent? He may look all right but, unfortunately, may not be prepotent for reasons that cannot be seen.

Prof. SHAW. That is a good thought. It is true, you may get a sire that is not prepotent, and who may be purely bred. There is another mistake that farmers make sometimes. They sometimes get a pure bred sire that is prepotent, but he is an inferior individual. He has prepotency of the wrong kind. A sire of that kind is dangerous. You remember when I was

talking, I presupposed that every sire chosen was good. A farmer should not use an inferior sire.

QUESTION. I would like to ask one question. How many sires were used in getting that result of ninety-nine good points of the same blood as the improved breed? That is, how many different sires were used in order to get that result?

Prof. SHAW. Five.

QUESTION. How could anybody tell? How could you get back to the blood of the original sire anywhere in that line?

Prof. SHAW. That depends on the man who is doing the work. I do not recommend it for a man who is not well versed in that work. He is very apt to make a mistake, but it can be done.

QUESTION. In other words, if we have a good sire this year, and next year a heifer should be bred to another sire, and the following heifer bred to still another sire, and so on down the line, do you get back to the original blood at all?

Prof. SHAW. That is the safest line of breeding, in my judgment. The other line may be adopted. A skillful man may adopt it. I might have attained this result by using simply three sires.

The PRESIDENT. Do you think that this rule is invariable? As I understand it, you say there is an invariable rule, but it does not seem to work always.

Prof. SHAW. The law of variation is always unquestionably operating.

Mr. STADMUELLER. I would like to ask a question as to how much the progress of breeding has been helped by not paying any attention to negative results? That is, suppose we select a sire, a prepotent sire, who has sired possibly a dozen cows of superior merit — doesn't that go to demonstrate some ability of the strain?

Prof. SHAW. I do not know that I understand the question. How do you explain that? Is that it?

Mr. STADMUELLER. In other words, do we not exagger-

ate our knowledge in general regarding breeding? Do we know very much about it as long as we get negative results? For instance, take a certain sire, and say that ninety per cent. of his progeny is excellent, I am afraid that the records would show that only a very small per cent. of the greatest sires that ever lived have amounted to anything.

Prof. SHAW. I think I understand you. You are quite correct now. You mean where the prepotency is maintained in a remarkable degree? That is certainly true. It is rare. It is easy to find it in a fair degree, but not in a remarkable degree. In one case out of twenty-seven sires, I think only five were remarkably prepotent, the rest were only ordinarily prepotent.

Secretary BROWN. I would like to ask Professor Shaw whether the result produced there is the result of theory or practice. Is that the practical result which is attained?

Prof. SHAW. Why, gentlemen, I have already told you this: We began at the Minnesota station with a range ewe, very common grade of sheep. The blood all mixed up. We have no other animals bred quite as the range sheep are. We began some experiments at the Minnesota station. We used pure bred Southdown sires, the best that we could get. The Southdown is a mutton sheep. In three generations we beat the world at Chicago. Mark you, it was not in five generations but in three, and with that kind of breeding. That shows whether the theory holds good in practice.

Mr. PHELPS. I think now we are getting to the meat of the whole question. The Professor made the statement that in five generations he will produce a herd, by breeding graded stock, which would be just as good as a thoroughbred herd. I think possibly Prof. Shaw can do it, but I do not believe that five per cent. of the farmers of the State of Connecticut can or will do it. Now we have an instance here of a young farmer, whom I have known for a number of years, who has been working to upbuild his herd. He has been breeding from Jer-

sey thoroughbred sires, and yet he says that only two out of five of the offspring have shown improvement over their dams. Now either the theory is wrong, or else the theory and the practice do not agree.

Prof. SHAW. Now just wait a moment. On what lines were those sires chosen? That is an important question.

Mr. PHELPS. I think that now we are getting to the heart of the matter. I think in five generations the average man will not produce a herd of graded stock that will be anywhere near equal to a herd of thoroughbreds, that the same man might probably produce, and I think it is owing to this reason. If he pays good money for a few thoroughbred females, he will be very ready to go out and pay a good, big sum of money for a sire to mate with such females. The average farmer has a herd of graded cattle which he knows to be worth from forty to fifty dollars, and he is not apt to use that care, and that forethought, and the amount of cash necessary, to get the kind of sire he ought to have. On the other hand, if he does not hesitate to pay for and use the right kind of a sire to mate with his grades, the result is much different. That, sometimes, is the reason why a man using thoroughbreds on both sides "gets there" faster than the man working with thoroughbreds on one side only.

Prof. SHAW. I did not say that he won't get there faster. I only say that what I have indicated is what the other man could do.

Mr. PHELPS. But I do not believe that five per cent. of the farmers of Connecticut will do it.

Prof. SHAW. I have shown you that it can be done in three generations.

Mr. STADTMUELLER. I am sorry that the gentleman who has been referred to has been obliged to leave the hall, because I believe he is a very good exponent of the very doctrine that Prof. Shaw has been promulgating this afternoon. He has been working upon the same identical theory. He has bred his

animals by using pure bred sires, and the proof that the theory works out in actual practice, is that he admits, on the whole, that his herd is better. Now, from my personal knowledge of the case, and from what I have heard him state at institutes, and from personal statements he has made to me, I am safe in saying that his herd has a larger product in butter fat, and in the production of fine butter than the average herd of thoroughbred Jerseys. He has accomplished every result that Prof. Shaw insists may be accomplished, but the average farmer of the State of Connecticut cannot afford to come to the thoroughbred cow, because it requires more capital, and in the general market, the product of the thoroughbred cow will not bring one cent more. That brings about a condition that we must remember. We are not going to help the average farmer by preaching to him the necessity of starting out with thoroughbred dams. He cannot do it. I am very glad of the explanation which has been given here this afternoon by the gentleman.

We ought not to forget the fact that we are bound to have some disappointments in breedings thoroughbreds. I have been breeding thoroughbreds for over twenty years, and out of every five, even with thoroughbreds, there are quite a proportion that are not successful.

Mr. PHELPS. I believe that both gentlemen are right. I believe, however, that we cannot afford to preach the doctrine that thoroughbred stock should not be kept by the average farmer, or, at least, by many more than now do keep it. I think, if a man is endeavoring to build up a good grade herd, the very best thing he can do is to mix in with that herd a small number of thoroughbred females, and then to breed the majority of his herd along grade lines, using, however, the same bull on the thoroughbred females that he does on the grade animals. Gradually, he will thus work from graded stock to thoroughbred stock, and then he will have a desirable

product, and, not only a desirable, but a salable class of offspring.

Prof. SHAW. Mr. Chairman, I am exceedingly thankful for the side-lights that have been let in on this question by the last two speakers. I would like to say in this connection that I do not want to discourage the breeding or sale of pure bred females. I would rather that all animals in America were pure bred or registered stock than to have them as they are, but what I wanted particularly to represent to this meeting was this: That while perhaps nineteen farmers out of twenty have not the money to buy pure bred females, they do have the money, as a rule, to buy one male, and that if a farmer has a large herd, he can effect a tremendous improvement in that herd in that way. Now the suggestion made is perfectly correct, but I say let him introduce the pure bred blood as he can. If he cannot do any better than that, then introduce it as he can by introducing pure bred females. I would recommend that, however, only under this condition, that if he finds he has made a success of his graded stock. If he has not made a success of his grading he has no business to touch the thoroughbred stock, for he will make less of a success with the pure bred if he has has not been making a success with the graded cattle.

A MEMBER. I would not object to it, provided the females had good strong stamina. I am a great stickler for stamina. I believe, gentlemen, that the difficulty with many of the pure bred sires today, is that we do not get stamina. If our animals are possessed of strong stamina of the right kind, we can use them to breed from.

Mr. PHELPS. Do you object to vicious sires, provided they are properly handled, for use in breeding stock?

Prof. SHAW. Well, I would like to know what causes the viciousness. There is a viciousness that is inherited. I do not like that. There is also a viciousness that is caused by a man who does not know how to handle that animal. If it arises from any such source as that, I would not object to breeding

from such an animal as long as the animal did not endanger somebody's life. It goes to show that such a sire has the right kind of vigor, such as I have been talking about. I do not like inherited viciousness, and would not recommend breeding from such a bull.

Mr. PHELPS. Are not some of the very best sires vicious sires?

Prof. SHAW. Yes sir, they are.

Mr. SEDGWICK. In breeding thoroughbreds, why do we get such a lack of uniformity in milk production among heifers of a given strain of blood? I have two three-year-old heifers, who are from two cows who are sisters by the same bull. The mothers are both what you might call smaller than the average as milkers. Both of these heifers came in about the same time and looked very much alike. One of them dried out at the end of three or four months. She did not hold out well in her milk at all. The other one continued for a year, and shows a tendency to a large yield or flow of milk still.

Now one thing further. I have bred Holstein cattle for the last twenty-five years, and I have noticed that same thing in thoroughbreds all the way along the line. It is an exception when you get an extra good heifer from among them. Why is that?

Prof. SHAW. There is no man in the United States that can answer that question. We simply have to recognize the fact. It is the outcome of the working of the law of variation, but why it is an outcome of the law of variation we cannot be quite sure. It may arise from the food, to some extent, or it may arise from exposure. From elements of that kind.

Mr. SEDGWICK. I have had precisely the same result from breeding what you might call scrubs; from these old red cattle of Connecticut. It seems to be impossible to get a uniform type that will increase the milk product in all instances.

Prof. SHAW. You cannot get any class of animals that will be uniform in producing good performances. There will al-

ways be variations. That never has been done since the world began. Whether it ever will be, I do not know.

QUESTION. I would like to ask the speaker if the progeny get their milk-producing power from the sire? Is that generally an acknowledged fact?

Prof. SHAW. I do not know whether you all heard that question. The gentleman asks the question whether the milking qualities are inherited from the sire or are they partly inherited from the sire and partly from the dam? I can answer that only in this way: that prepotence is always inherited from the animal that is the more prepotent. Whichever one is the more prepotent, the inheritance will be from that end. It is usually from the sire, because the sire is most always the more prepotent, but I would say right here that I am a believer in the fact that a male as such transmits such properties to the female. The female also transmits certain properties.

A MEMBER. A man must use his eyes in breeding cattle. I have had considerable experience in breeding. I bred for several years from graded bulls, and afterwards used a thoroughbred bull, which was not registered, and which was supposed to be selected with great care. It came from some of the most fashionable stock in the State of Wisconsin, but that bull proved worthless to breed from. He was a thoroughbred bull, but simply because he was not registered, did not have the standing of thoroughbred registered stock. Every farmer that wants to spend his money for a thoroughbred sire has got to choose wisely, or he is going to lose.

Prof. SHAW. That is a very good point.

A MEMBER. Can that be stated again? We did not hear that question back here.

Prof. SHAW. The substance of the statement of the gentleman is that a graded sire had been used, and afterwards unregistered sires chosen with very great care, and the results from the former were better than the results from the latter. I can readily understand how that would be possible, because

you know if an animal is bred after the method I have been talking about for, say, about ten generations, even then you cannot get that animal recorded according to the rules in force now in any herd book. That sire, bred in that way, and particularly chosen, might be better than any registered sire. I will admit that.

Mr. PHELPS. There is one very important lesson brought out right there, and that is, that a pedigree is nothing more or less than a record of the ancestry of an animal, and may be worth two cents, and it may be worth two hundred dollars. There may be an instance where an animal has no pedigree, simply because there was no printed record kept of the ancestry of the animal, yet it would not hurt the animal for breeding purposes. On the other hand, there are many animals with big, long pedigrees, which are of little value either for their direct product or their offspring.

A MEMBER. I have listened with a good deal of pleasure to the statement which the Professor has made concerning his success at the international stock show, with his Southdown sheep, and I would like to ask this question. I am not a stock breeder, but I am curious if you are going to breed animals, for instance, mutton sheep, to send to the international stock show, would you, if you were going to do that again, select dams from range sheep and breed them with a fine Southdown, or would you breed the Southdown pure?

Prof. SHAW. I would rather prefer the former course.

A MEMBER. With the native range sheep?

Prof. SHAW. Yes, and I will tell you why. There is no harm in introducing a little alien blood. That is very apt to strengthen the strain. Now I am ready to quarrel with all the live stock associations in the United States on this point, but no matter about that now. If an animal is bred for twenty generations in that way you cannot get that animal recorded in any herd book. I think it is a damage to the breeding interests, but perhaps that caution may be necessary. Be that as it may,

a little alien blood gives stamina and generally increases the size, and does not prevent grading the stock up to a thoroughbred standard, provided it is chosen in the right way.

A MEMBER. Could you, with your experience and your ability in choosing Southdown ewes, if you picked them out and bred them with your Southdown bucks, couldn't you get as good results as to go out on the range and use the same number of range animals?

Prof. SHAW. Well, I think there would not be much difference, but it would depend upon the range of choice that I had. I think it could be done. Of course, it could be done more quickly. If you took the other course, you would have to breed through three or four generations.

A MEMBER. But you are going to spend six or eight years in getting your high-grade stock that way where it might have been attained by the first course, are you not?

Prof. SHAW. I do not say I would rather do that. I say it can be done that way.

A MEMBER. How long will it take you to get that ninety-nine and two-thirds per cent. animal, how many years after you start?

Prof. SHAW. Five. There it is on the blackboard.

Q. Do you get those five generations in five years?

Prof. SHAW. I beg your pardon, but it would take at least ten years.

Q. Then why couldn't you start with a few good, well-bred animals and get more money in ten years by breeding than you are able to get by that plan? Is it not possible? I am asking practical questions, and not trying to bring up any side-light discussions.

Prof. SHAW. There may be some farmers present who have some two-thirds Jersey cows, we will say, today. There may be others present who have scrubs. Now the man who has the two-thirds Jersey, if he wants to improve his stock, he has got that much further on than the other man, and he will

get to the perfection point so much the quicker because he is two-thirds of the way now. You see the point.

Q. What is the expense of such a sire as you speak of, and where would I go to work to find such a sire?

Prof. SHAW. It is impossible to answer that question definitely. The price might run all the way from fifty dollars to five hundred dollars. Of course, it would be absolutely absurd for an ordinary farmer to buy a five hundred dollar sire for a common herd, but I think he might afford, probably, to pay a hundred dollars, and, generally speaking, good sires of that kind can be gotten for near that price. For thorough-bred sires, of course, a man has to pay more.

Mr. TILLINGHAST. Mr. Chairman, I would like to ask the Professor if what he has said about animals would apply to poultry. Would the same law govern in poultry breeding?

Prof. SHAW. I am almost sorry that the gentleman put that question. Inasmuch as he puts it, I will answer it, but it conflicts with what I heard on this platform a little while ago. I should answer unhesitatingly yes, but I heard the statement from this platform, if I understood the speaker aright, and I am sorry he is not here to correct me, if I am mistaken — I heard him say that cross breeding, which is just the kind of grading I am talking about, would give seventeen cent eggs instead of forty cent eggs. I cannot understand that, gentlemen. I think I would rather trust to cross breeding to improve my stock, whether animals or poultry.

The PRESIDENT. This convention will stand adjourned until seven-thirty this evening.

EVENING SESSION.

December 13, 1905.

Music.

Convention called to order at 8 p. m., Vice-President Seeley in the chair.

The PRESIDENT. We are to have a stereopticon address this evening, the subject of which is "How shall we attract useful birds about our farm homes." Dr. Edward Howe Forbush, of Wareham, Mass., is the gentleman who will give the address, and he is now on the platform. I take great pleasure in introducing him to you.

HOW SHALL WE ATTRACT USEFUL BIRDS ABOUT OUR FARM HOMES.

BY EDWARD HOWE FORBUSH, WAREHAM, MASS.

Horace Greeley once said that the farmer who allows a man to shoot his birds would be just as consistent were he to allow him to shoot his cattle, for one is of as much value as the other. While this may be an extreme statement, it is probable that were all the birds destroyed the consequences would be quite as serious to the farmer as would be the destruction of all his cattle. Few people realize the value of the services that birds render to man in checking the multiplication of insect life.

When we fully appreciate the number, the fecundity, and the consuming powers of insects they assume an economic importance greater than can be accorded to the ravaging beast of prey. Let us consider briefly the potency for evil that lies hidden in the tiny but innumerable eggs of injurious insects which require only the summer sun to give them destructive life.

The number of insect species is greater by far than that of all other living creatures combined. (More than three hundred thousand already have been described.) There are many thousands of undescribed species in museums. Dr. Lintner, the late distinguished State Entomologist of New York, considered it not improbable that a million species of insects would be found in existence. The number of individual insects is beyond human computation. Dr. Lintner says that he saw at a glance, in a small extent of roadway near Albany, more individuals of a single species of snow-flea, as computed by him, than there are human beings on the face of the earth. A small cherry tree, ten feet in height, was found by Dr. Fitch to be infested with an aphid or plant-louse. He estimated, first counting the number of these insects on a leaf, the number of leaves

on a branch, and the number of branches on the tree, that there were twelve million plant-lice on that tree; and it was only one tree of a row similarly infested. To give the reader an approximate idea of the number of insects on the tree, it was stated that were a man to count them singly and as rapidly as he could speak, it would require eleven months' labor at ten hours a day to complete the enumeration.

Insects are enormously reproductive, and were the progeny of one pair allowed to reproduce without check they would cover, in time, the entire habitable earth. The rapidity of propagation as shown in some insects is, perhaps, without a parallel in the animal world. In order to give some idea of the powers of multiplication of the Colorado potato beetle, the *Canadian Entomologist* states that all its transformations are effected in fifty days, so that the progeny of a single pair, if allowed to increase without molestation, would amount, in one season, to over sixty millions. Speaking of the power of multiplication shown by plant-lice, or aphids, Dr. Lintner says that Professor Riley, in his studies of the hop vine aphid (*Phorodon humuli*) has observed thirteen generations of the species in the year. Now if we assume the average number of young produced by one female to be one hundred, and that every individual attains maturity and produces its full complement of young (which, however, never occurs in nature), the number of the twelfth brood alone, not counting those of all the preceding broods of the same year, would be 10,000,000,000,000,000,000,000,000 (ten sextillions) of individuals. Where, as in this instance, figures fail to convey any adequate conception of numbers, let us take space and the velocity of light as measures. Were this brood marshaled in line with ten individuals to a linear inch, touching one another, the procession would extend to the sun (a space which light traverses in eight minutes) and beyond it to the nearest fixed star (traversed by light only in six years), and still onward in space beyond the most distant star that the strongest telescope may bring to our view, to a point so inconceivably remote that light could only reach us from it in twenty-five hundred years. The smallest approach to such unchecked multiplication on the part of this insect might paralyze the hop-growing industry. While the aphids may represent the extreme of fecundity, there are thousands of insect species, the unchecked increase of any one



**MR. DIKE, WHO FEEDS THE WILD BIRDS ABOUT HIS HOME, IS HERE SHOWN
WITH A CHICKADEE EATING SEEDS FROM HIS CAP.**

of which would soon overrun a continent. Kirkland has computed that the unrestricted increase of the gypsy moth would be so great that the progeny of one pair would be numerous enough in eight years to devour all the foliage in the United States.

Many insects are remarkably destructive because of the enormous amount of food which they must consume to grow rapidly to maturity. Many caterpillars eat daily twice their weight of leaves, which is as if an ox were to devour every twenty-four hours three-quarters of a ton of grass. Their voracity and rapid growth may be shown by the statement of a few facts: A certain flesh-feeding larva will consume, in twenty-four hours, two hundred times its original weight; a parallel to which, in the human race, would be an infant consuming, in the first day of its existence, fifteen hundred pounds of food. There are vegetable feeders, caterpillars, that during their progress to maturity within thirty days, increase in size ten thousand times. To equal this remarkable growth, a man at his maturity would have to weigh forty tons. Mr. Leopold Trouvelot, who introduced the gypsy moth into this country, says: "The food taken by a single American silkworm (*Telea Polyphemus*) in fifty-six days equals in weight eighty-six thousand times the primitive weight of the worm." In view of such statements, need we wonder that the insect world is so destructive and so potent a power for harm!

When we consider the dangers arising from the immense numbers, fecundity, and voracity of insects, the fact that insects new to cultivated crops are constantly appearing becomes a source of grave apprehension. Every year economic entomologists, who are constantly increasing our knowledge regarding insect pests, discover new insects attacking important crops or trees. Dr. Lintner made a list of insects injuring apple trees in the United States, which was published in the appendix to his first report as entomologist of New York state. It contained one hundred and seventy-six species, while large though lesser numbers have been found on the plum, pear, peach, and cherry. Dr. Packard described four hundred and forty-two species which prey upon our oaks, and believed it not impossible that ultimately the number of species found on the oaks of the United States would be from six to eight hundred or even one thousand. The list of insects which feed on grasses,

cereals, field and garden crops is very large and constantly growing, for it is continually receiving accessions both from native and foreign sources.

The destructiveness of some of these insects is so enormous as to amount to a heavy annual tax on the people of the United States. Hence, since the first settlement of the country, the amount of this annual tax has been increasing. In September, 1868, Professor D. B. Walsh, editor of the *American Entomologist*, estimated that the country then suffered from the depredations of noxious insects to the amount of three hundred million dollars annually. By the census of 1875, the agricultural products of this country were valued at two billion five hundred million dollars. Of this amount, says Dr. Packard, we, in all probability, annually lose over two hundred million dollars from the attacks of injurious insects. In the report of the Department of Agriculture for 1884, the losses occasioned by insects injurious to agriculture in the United States, it is said, are variously estimated at from three hundred million dollars to four hundred million dollars annually. In 1890, Professor C. V. Riley, in response to a letter of inquiry, stated that no very recent estimate of the injury done to crops by insects had been made, but that he had estimated some time previously that the injury to agriculture by insects in the United States exceeded three hundred million dollars annually. Mr. James Fletcher, in his annual address as president of the Society of Economic Entomologists, in Washington, in 1891, stated that the agricultural products of the United States were then estimated at about three billion eight hundred million dollars. It was believed that a sum equal to about one-tenth this amount, or three hundred and eighty million dollars, was lost through the ravages of injurious insects. The latest calculation of the loss occasioned by insect injury in the United States which has come to my notice is that of Dr. C. L. Marlatt, who, by careful estimates, approximates the percentage of loss to cereal products, hay, cotton, tobacco, truck crops, sugars, fruits, forests, miscellaneous crops, animal products, and products in storage. Dr. Marlatt attributes a loss of eighty million dollars to the corn crop alone, and approximates the loss to the wheat crop at one hundred millions each year. The injury done to the hay crop is estimated at five hundred and thirty thousand dollars, while the codling moth alone is believed to

injure fruit crops to the amount of twenty million dollars. His statement, based on the value of farm products as given in the Reports of the Bureau of Statistics of the United States. Department of Agriculture for 1904, gives the loss from insect depredations for that year as seven hundred and ninety-five million one hundred thousand dollars, and this is believed to be a conservative estimate of the tax now imposed by injurious insects on the people of the United States, without reckoning the millions of dollars that are expended annually in labor and insecticides in prosecuting the fight against insects.*

In considering the losses caused by insect pests, and the possibility of preventing them, it is well for us first to observe how nature, if left to herself, provides a system of checks, which in the forest or wilderness operate to maintain the balance of life so nicely that, ordinarily, neither low-growing plants, shrubby, nor trees, suffer greatly from the attacks of insects.

First, birds, bats, other insectivorous mammals, batrachians, reptiles, and predaceous insects, feed upon injurious insects, and thus hold their increase in check. These are the primary controlling agencies. When these fail, parasitic insects, increasing, attack the insect hosts, and when these also prove ineffective — when vegetation is destroyed and the food supply exhausted — disease and starvation kill off the swarming insects and give vegetation a chance to renew itself. These latter agencies, which are so effective under natural conditions, are of less immediate service to the farmer, however, in checking injurious insects than are the birds, for, although parasites, disease or starvation, ultimately check many great outbreaks of injurious insects, these most effective checks do not avail until such insects are most numerous, usually in the second year of their abundance, when it is too late to save the crops. The birds, on the contrary, form a mobile standing army, that can be concentrated at once upon any insect outbreak, reducing it before it has done much harm. This quelling of insect invasions by birds is a common occurrence, but is seldom noticed for the reason that birds often suppress the insect uprising before it has become apparent to common observation, or has done any considerable injury. The instances where birds fail to check insect outbreaks at once attract attention, for then

* "The annual loss occasioned by destructive insects in the United States," by C. L. Marlatt, Year book, U. S. Department of Agriculture, 1904, p. 464.

these uprisings soon become apparent because of the injury they do. Birds would ordinarily hold in check all insects which they eat with avidity were it not (1) that the birds have been much reduced in numbers; (2) that man in planting and cultivating crops makes conditions favorable for the propagation of insects and unfavorable to the increase of birds. Many species of birds, especially game birds, are gradually disappearing; a few are extinct. The farmer, by devoting large areas to a special crop, and growing the same crops year after year, offers the insects that infest those crops a splendid opportunity to multiply, while the cultivation of the field drives out the birds that formerly nested there.

Birds are remarkably active and energetic creatures, having a high temperature, rapid circulation and respiration, and requiring a tremendous amount of food to sustain their activity and repair the waste of the tissues.

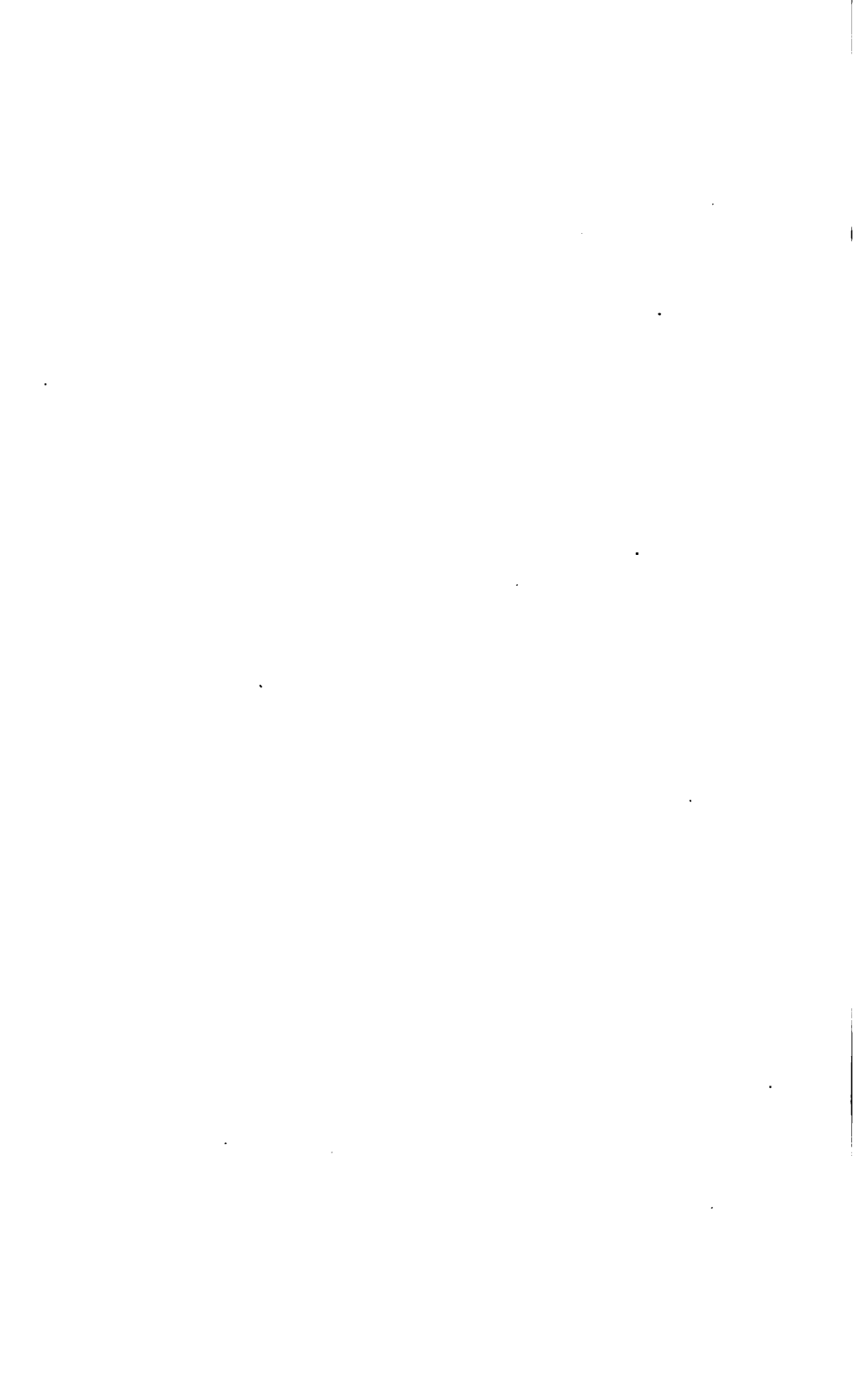
Some of the smaller birds require only half an hour to an hour and a half to digest a full meal, and the stomach is filled many times each day. The rapidly growing young need far more food in proportion to their size than do the old birds. An adult crow will eat from five to eight ounces of food daily. A young crow, nearly fledged, requires about ten ounces. Professor Treadwell found that a young robin needed, daily, a quantity of beef equal to one-half its own weight, or forty-eight per cent. more than its own weight in worms, to secure its healthy growth and development. Where insects are numerous, birds eat them with almost incredible rapidity. My assistant, Mr. F. H. Mosher, saw a pair of tanagers eat thirty-five newly hatched caterpillars in a minute. They continued eating these minute insects at this rate for eighteen minutes; so that, if Mr. Mosher's count is correct, they must have eaten in this short time six hundred and thirty of the little creatures. This would not make them a full meal, as the entire number would hardly be equal in bulk to one full-grown caterpillar. By carefully watching two yellowthroats, and counting the plant-lice they ate, he estimated that they destroyed seven thousand within an hour,—a thing almost incredible, but still possible, when we consider the exceedingly small size of the insects at the time, their swarming numbers, the activity of the chickadee, and its remarkably rapid digestion. Dr. Judd speaks of a letter received from Mr. Robert H. Coleman, in which he



A HOME FOR A SCREECH OWL.



**DOWNY WOODPECKER ATTRACTED TO
THE WINDOW BY SUET.**





VIREO FEEDING HER YOUNG.
(Photograph by C. A. Reed.)

says of a palm warbler that he watched, that it must have killed nine thousand five hundred insects in about four hours. These may be extreme cases, but even if we halve the numbers given, they will still show the bird's possibilities for good.

The remarkable appetites of the young birds keep their parents very busy. The old birds usually carry to the young from one to twelve insects at each visit to the nest, although some visits are made for other purposes. A pair of vireos visited the nest one hundred and twenty-five times in ten hours. A pair of chippies made nearly two hundred visits to their young in a day. Two martins have been seen to visit their young three hundred and twelve times in fourteen hours. A pair of rose-breasted grosbeaks made four hundred and thirty-six calls at the nest in eleven hours. House wrens have been seen to enter their nest from thirty to seventy-one times an hour.

If we turn for a moment to the records of the amount of food found in birds' stomachs by dissection, we can see at once why they are such effective checks on the increase of insects. A large part of the alimentary canal is often packed with food. The stomach of a bird is not seldom found to contain, as Professor Beal remarks, enough food to form a pile "two or three times as large as the original stomach with food all in it." Where birds have no crop or special enlargement of the gullet, to contain an extra supply of food, the whole gullet is used for this purpose, and when favorite food is abundant the bird will fill itself to the throat. The amount of food found in the stomachs of birds, as given by the investigators connected with the United States Biological Survey, seems large, but anyone can verify the statements made by examining the stomachs for himself, for they are all preserved and kept for reference. Professor Beal found in the stomach of a yellow-billed cuckoo two hundred and seventeen fall web worms, and in another two hundred and fifty American tent caterpillars. Two flickers were found to have eaten respectively three thousand and five thousand ants. Sixty grasshoppers were found in one night-hawk's stomach, and Professor Harvey has found five hundred mosquitoes in another. Seven thousand five hundred seeds of wood sorrel had been eaten by a mourning dove, six thousand four hundred by another, and nine thousand two hundred, chiefly of weeds, were found in a third. Dr. Judd says that the

stomachs of three bank swallows contained, altogether, two hundred ants, and a nighthawk has been known to take a thousand at a single meal. One thousand seven hundred seeds of weeds had been taken at one feeding by a bob-white; three thousand leguminous seeds were found in another, and no less than five thousand seeds of pigeon grass were taken from a third. Dr. Warren has taken twenty-eight cut-worms from the stomach of a red-winged blackbird. Stomachs of snow-flakes examined at the Biological Survey have contained from five hundred to fifteen hundred weed seeds. Professor Forbes took from the stomachs of seven cedar birds, or cherry birds, nearly one hundred canker worms each. In a letter recently received from Professor Beal he says that one hundred entire beetles were found in the stomach of a cliff swallow; that from the stomach of a yellow-billed cuckoo there were taken the remains of eighty-two caterpillars, each of which was originally from one to one and one-half inches long; another had taken eighty-six, and from forty to sixty were found in several others. From the stomach of a Franklin gull there were taken seventy entire grasshoppers, and the jaws of ninety-five more, showing that it had eaten one hundred and sixty-five grasshoppers. Another contained ninety grasshoppers and one hundred and two additional jaws. Another contained sixty-eight crickets. These grasshoppers and crickets were each more than an inch in length. When we consider that the digestion of birds is continuous, and that when food is plentiful the stomach is filled many times each day, the effect that must be produced on the insects with which birds satisfy their appetites will be more clearly understood. There are many records of the benefits resulting from the insectivorous habits of birds, and many others which tell of the increase of injurious insects which has followed the destruction of birds, but time will not allow me to quote them here, for the chief question to be considered tonight is, "How shall we attract and protect the useful birds about our homes?"

He who is about to purchase a farm or country place may, by keeping in mind the attractions which birds require, secure a place naturally well adapted to their wants. Such a place should be so situated as to provide shelter from cold northerly winds and storms. It must be well watered, and partly wooded with groves or patches of evergreen trees and windbrakes of



**A CHICKADEE COMES TO MR. A. C. DIKE'S DOORSTEP AND ALIGHTS
UPON HIS KNEE.**

trees, shrubs, and vines. It should be near a small swamp, a meadow, or large stream, which should also be sheltered by woods or hills upon its north side. It should have a great diversity of wild vegetation, including a variety of fruit-bearing trees, shrubs and vines. If the place be situated in a broad river valley, it is likely to be visited by many migrating birds.

Were I selecting a place with special reference to its fitness to maintain bird life, I should prefer to have a large portion of the land wooded. If there are too many trees, they can be cut in much less time than it takes to grow them, and those trees, shrubs and vines, especially attractive to desirable birds, can be left. There should be an orchard with some trees going to decay, thus furnishing homes for woodpeckers and cavities for such birds as nest in them. There should also be an old field, much pasture and mowing land, with cleared land enough besides for garden and cornfield. As this is a brief description of many New England farms, one need not go far to find such a place.

The cultivated cherries are well known to be among the most attractive of bird foods, and those who have enough cherries for themselves and the birds are fortunate. Those not well provided with cherries may protect their fruit by planting the Russian mulberry or shadberry, for these fruits ripen as early as the earliest cherries and appear to be preferred by the birds. The greatest difficulty encountered in cultivating the shadberry, is that the birds get all the fruit. Since I first learned, by my own experience in Medford, that birds prefer mulberries to cherries, I have found that many farmers and fruit growers have had a similar experience.

We may protect our fruit in this manner, but how shall we get the best results from the presence of the birds? At present birds are not often numerous enough to do more than reduce somewhat the numbers of injurious insects. Birds have abundant choice of insect food and are not compelled to make a close search for their prey. Now if we can attract more birds to our orchards than would ordinarily come there, and keep them there, especially in winter, by supplying them with a little inexpensive food to tide them over the storms, they will search the trees so thoroughly that few insects will escape. If we wish to secure the greatest good possible from birds at points threatened with insect attack, we must maintain

there a larger bird population than the land will support under ordinary conditions. How to do this with the least trouble and expense becomes our next study. It is well to begin with the winter birds, as they are of the utmost importance to the farmer because of their destruction of weed seeds and hibernating forms of insects. Insects lie dormant in some form for six months or longer, each year, and so they cannot escape the attacks of birds. The winter birds are obliged by necessity to search them out. One bird can destroy, during a winter, at least one hundred times as many insects in embryo as it can in the same time in summer when the insects have grown larger. In winter, the farmer is likely to have more time to attend to birds than in summer, and at that time they most need his help. No doubt thousands of birds are starved in hard winters that might be saved with very little trouble on the farmer's part.

It is very desirable to keep with us, so long as possible, the many species of sparrows which pass through the country on their way south in the fall, and to persuade some of them to remain through the winter. Careless husbandry tends to bring these birds about; they gather to feed upon weed seeds in neglected gardens and fields. But if we wish to have them continue this good work all through the winter and spring, they must be provided with food and shelter to which they can resort during snow storms and afterward while the snow lies deep, or when all vegetation is covered with a coating of ice from driving sleet or freezing rain. Unless they are thus provided for, they must either go farther south or succumb to the inclemency of winter.

The sparrows prefer the shelter afforded by thickets, and tangles of deciduous bushes and vines, such as are sometimes found on the south side of a hill near the edge of a swamp. A few brush piles will give them additional shelter. A little chaff from the barn floor scattered in the dooryard, whenever a flurry of snow covers the ground, will bring them about the house. Where there are scratching sheds for poultry, with the south side of each shed open except for its screen of poultry netting, the birds will find shelter and food on cold stormy mornings. These sheds are strewn with straw or other litter, which is likely to contain weed seeds, and fine particles of grain overlooked by the fowls. In time the birds become bold



CHICKADEES (SEEN THROUGH THE WINDOW) FEEDING ON SUET.



A WINTER SHELTER FOR BIRDS.

enough to enter the sheds even when the fowls are there, and they will always resort to them in the early morning before the hens are out. Birds readily pass through ordinary poultry netting, and when once in the sheds they are safe from the attacks of cats and hawks. Those who wish to provide any food more attractive than the above, have their choice of the various seeds sold at the bird stores.

Farmers should always grow sunflowers for the fowls. These will attract goldfinches; sunflower heads or the detached seeds make a good winter bird food. If the farmer wishes other bird food, he can give one or more of the children a small patch of land near the house on which to raise Japanese millet. This is merely a cultivated and improved variety of barnyard grass (a common weed) and sparrows seem to be fond of it. If sown broadcast on rich, moist soil, it will grow from five to seven feet in height, and the large seed heads will supply an immense quantity of seed. It takes but three or four square rods of land to produce all the seed one will need for birds in winter. A bushel or two ought to suffice for the birds during an ordinary winter.

Winter is the time to feed jays and crows. If they do not molest the smaller birds, they can do no harm in winter, and they may do much good. In Massachusetts the jays are already learning to eat the larvæ of that notorious pest, the brown-tail moth, which hibernates in winter in "nests" upon the limbs and twigs.

Hang up a bit of worthless meat in a tree. It should be high enough from the ground to be out of reach of dogs and far enough from the house so that the cautious crow will trust his precious skin within the distance. The skinned carcass of a fox or cat will do very well; but it will not last long after the crows find it. It should be so placed that they can find no convenient roost within reach of it, for it will then last the longer and keep more crows from starvation. When the snow is deep they will resort to it, and when the ground is more or less bare, they will still remain and hunt field mice and hibernating insects in the fields or the shrubbery along walls and fences.

Woodpeckers, nuthatches, and chickadees are all attracted by animal food. Juncos and tree sparrows will eat it during deep snows when their usual food is buried. Unsalted bones with meat, fat, or marrow attached, beef or mutton tallow, fat

or suet, all may be used for this purpose. Uncleaned bones from the market hung upon the orchard trees will furnish food for these birds. Fat or suet will give them the needed animal heat on which they must rely during the coldest weather. If a bird can get food enough, it can withstand very cold weather, but if it starves, it soon freezes. Bones and suet should be put out early in the fall, that they may attract and hold birds that are migrating. These food materials should be renewed occasionally until late in spring, for when we have once taught the birds to rely upon them, we must keep up the supply, if we wish to retain the birds; if they are not provided with a never-failing food supply, storms may drive them away or starve them. When birds have found the food provided for them and have become accustomed to look for it daily, we may, if we will, attract them about or even into our dwellings.

Chickadees and nuthatches are remarkably unsuspicious, and may be taught to eat from the hand of any one who cares to spend the time necessary to accomplish that end.

Several other species may be enticed to our doors and windows, where their habits and manners may be watched and studied in comfort during the most inclement winter weather. To accomplish this, and at the same time to see the birds upon the limbs and in their natural attitudes, small shrubs or branches may be fastened upright to each window sill that may be selected as most convenient for the purpose. The branchlets and twigs may extend over the entire window and they may be further supported by being tacked here and there to the window frame. Small pieces of meat, fat or suet, may then be tied on the branches. These morsels should be well wound with twine, to prevent any bird from tearing one down or carrying it off bodily, and should be tied up about a foot apart that the birds may all have an opportunity to come at the same time, if they wish to do so. If only one piece of meat is provided, the birds are likely to fight over it, or to drive one another away; but if the above directions are followed, they will soon learn that there is enough for all, and several birds may be seen feeding at once at the same window. While these birds are being thus attracted to the windows, the sparrows also may be drawn about the house by chaff or bird seed thrown upon the ground or snow.





**THE BIRDS' CHRISTMAS TREE.
(CHICKADEE FEEDING.)**



JUNCOS ON THE WINDOW SHELF.

Next a shelf or table may be made of half-inch box boards. The side of a large shoe box will do. This may be covered with old bagging and a cleat or rail put about the edge to prevent the food put on it from blowing away. A little evergreen tree may be set up on the shelf which is then fastened under a window sill, as seen in the plate, and the birds' Christmas tree is ready. Various food materials are fastened to the tree. Chaff and seed are scattered on the shelf, and when the first snowstorm comes, if not before, sparrows, chickadees, woodpeckers, and perhaps even jays will visit the shelf at intervals all day. This feeding shelf can be attended to, the snow brushed off, and the food replenished from within by merely opening the window. If the birds are shy at first, a lace sash curtain may be put up, and any one may then sit at the window and watch them as well as though they were hung up in a cage in the house. The birds may quarrel some at first, but they will soon learn to feed together in amity, and so with very little trouble and care we can establish a winter aviary out of doors. This shelf should be high enough to be out of the reach of cats and dogs, so that the birds may feel safe in coming there. In time they will become so tame that they will come into the house when the window is left open and will take food from the table. We have to keep the doors and windows closed at my home, else the birds will come into the house. The chickadees always come into the woodshed when the door is left open, and there they search the woodpile for borers. One bird came several times to take from the hand a borer that was held out to him. We have had about the house at different times, flocks of from thirty to fifty juncos and tree sparrows, many jays and chickadees, and one or two pairs of nuthatches of both the common species; while flickers, kinglets, creepers, cross-bills, robins, quail, and pheasants come in greater or less numbers. In 1903-04 two fox sparrows stayed all winter, and this year a towhee or chewink is still with us. Myrtle warblers and meadow larks are commonly seen, and one season a pine warbler came in January. Their presence gives a healthy stimulus to observation and serves to break the monotony of winter isolation upon the farm, while as one result of it our trees are seen all summer in full foliage and never suffer seriously from the attacks of insects. The sparrows also help by eating most of the weed seed in the garden.

Our first attempt at availing ourselves of the services of winter birds was made in 1896. The birds were attracted to an old orchard by the methods just described, and in the fall, winter, and spring they destroyed thousands of the eggs of the cankerworm and tent caterpillar moths, probably also the larvæ and pupæ of the codling moth, as well as scale insects, and other enemies of the trees. When spring came, efforts were made to attract the summer birds to the orchard with such success that they destroyed most of the insects that were left by the winter birds, and our orchard retained its foliage and bore a good crop of fruit in a year, when nearly every other orchard in the town (Medford, Mass.) was leafless and fruitless because of the prevalence of insect pests.

The food of the birds in our orchard was carefully studied, and the numbers of insects consumed by them estimated. For example, four chickadees were found to have eaten at one meal one thousand and twenty-eight eggs of the fall cankerworm moth. Four birds killed later in the season were found to have eaten one hundred and five egg-bearing females of the spring cankerworm moth. As the female moths had, on the average, one hundred and eighty-five eggs each in their ovaries, these four birds had destroyed at one meal over nineteen thousand of these eggs. My assistant, Mr. C. E. Bailey, estimated that each chickadee would consume each spring 138,750 of these eggs. It is easy to see why our trees were not leafless that summer. In spring and summer, birds are attracted about our homes mainly by the insects and fruit to be found there, and if the farm is well provided with these, there ought to be no dearth of birds. Still it is a good plan to keep our feeding shelf supplied with food all the year round, and in warm weather, a pan of fresh water will be used daily unless there are other places near by, at which the birds can drink or bathe. At nesting time a little nesting material hung on tree or fence will sometimes decide birds to nest near by. Swallows and phœbes may be induced to nest, if they have free entrance into the farm buildings, and projections are available on beam or rafter, which will give needed support to their nests. But the most successful plan to assure the presence of certain birds, is to put up bird houses and nesting boxes. These boxes may be inexpensive. Large cigar boxes will do for wrens, but should





INEXPENSIVE NESTING BOXES.



YOUNG CHICKADEE JUST FROM THE BOX.
(Photograph by C. A. Reed.)

be used only where sheltered from the weather, for sun and rain will soon warp and crack them, thus rendering them leaky and unfit for use. Other small boxes may be utilized. Very acceptable bird boxes may be made of hollow limbs.

For practical utility a nesting box should not only provide the birds with an acceptable nesting site, but it should also furnish them perfect protection from the elements, and should be so made that the interior can be quickly examined and the contents removed, if necessary. The entrance must not face prevailing storms. The box must be so strong that woodpeckers cannot easily enlarge the entrance sufficiently to allow enemies of the occupants to get in. It must be placed beyond the reach of cats or other night prowlers. All these essentials may be secured without expense by using worn-out or discarded utensils or receptacles. In a few minutes an empty tomato can may be made into a bird box by slitting the tin of the opened end twice and turning down the piece between the slits, thereby making a hole not over an inch wide and high. It can be put up very quickly by placing the bottom of the can against a tree trunk and nailing it there with two wire nails driven diagonally through the edge, or by fastening it to a board or pole, which can be attached to a tree or building. The cover may be kept in place by pinching the mouth of the can a little. This is a practical box for wrens, and it may be used by bluebirds, if the entrance is made larger. When holes are cut through tin, the sharp edges around the opening should be turned over with a pair of pliers, that the birds may not injure themselves while passing in or out. Rusty or painted tin is the best, for birds seem suspicious of bright surfaces. There should be a few nail holes in the lower side, to allow any water that drives in to escape. Milk cans, oil cans, tin tea kettles, large tin funnels, flower pots, sections of stovepipe, drain pipe, and various other objects may be utilized, but those are best which, like pails, milk cans, or tea kettles, have removable covers. The cover should also be made to fit rather tightly, that it may not be too easily removed.

My experience indicates that chickadees prefer a wooden doorway to their tin castle.

Ornamental bird houses add to the attractiveness of a country home, and may be displayed where old tin cans and cheap bird boxes would be out of place. In building such bird

houses, the best plan is to imitate the design of some dwelling. A pretty cottage or country villa in miniature may be constructed.

A house for a large martin colony ordinarily involves the expenditure of a considerable sum; but a very good house that will accommodate a colony of ordinary size, may be made from a flour barrel. The roof is of zinc, or of wood covered with painted canvas. The house should be placed on a pole, at least fifteen feet high. It should have several large rooms, six or eight inches square, with entrances two or three inches in diameter, that it may offer plenty of room for several pairs of birds, and that each tenement may be readily inspected and cleaned when necessary. A house of this size will accommodate so large a community of martins, that when once intrenched within, they will be able to hold their own against bluebirds, or sparrows. The rooms should be so tight that there can be no draft, and the whole house should be painted in light colors, that the young birds may not suffer too much from the rays of the hot sun. It is well to have the floor of each tenement a few inches below the entrance, that the young birds may not be readily pushed or crowded out of the nest and so become a prey for cats. Such a catastrophe may be still further guarded against by having a piazza extending around the house below each tier of doorways, and constructing a railing three inches high around it. Each of these platforms should have a slight downward slope, to carry off the rain and prevent it from driving into the doorways below. In fitting up rooms, a square box should first be made to go up the center of the barrel. All the rooms will be backed by this, and the pole will go into it.

Generally a bird will use a box much larger than it needs, but it will not occupy one which it deems too small. For chickadees, the hole should be at least nine inches from the bottom of the box; they sometimes use a one and one-eighth inch hole, but prefer one an inch and a quarter in diameter. The entrance should not be larger, for then the bluebirds or swallows may use it. Bluebirds require a one and one-half inch entrance, while a two-inch hole will do for martins.

During the past few years I have been experimenting with nesting boxes, in the hope of attracting about the house some birds that do not ordinarily breed there. As there were a few





THE "OBSERVATION BOX" ON THE
WINDOW SILL.



A CHICKADEE FAMILY IN A WINDOW BOX.

chickadees in the woods not far away, I first attracted them to the house in winter by putting out food, then I put up a few boxes near the house in the hope that the chickadees might use them. As spring approached all the hollow trees and decayed stumps that might be chosen as nesting places by these birds within a radius of many rods of the house were cut down. Soon a pair of chickadees began to build a nest in what we called an observation box, which had been attached to the sill of an upper window. This was made after a pattern which I began using thirty years ago, and is illustrated here. The large door is kept closed until the birds have nested and the young have hatched, after which it may be opened at will, and all the family affairs of the birds may be observed through a pane of glass which is inserted in the rabbet into which the door closes. This box is quite safe for the young birds, as the hot sun cannot shine into it, and they cannot be seen, except from the window on the stool of which the box is fastened. Seven young were reared from this nest the first season, and other broods have been graduated from it since. Another box on a near-by apple tree has become the nursery of several more broods. Still another box was fastened to the frame of a kitchen window within a few feet of a door opening outward. A quantity of cotton was placed in this box, in the belief that it would form a warm nest for the birds on cold winter nights, and we thought that one or more of them occupied it at times. Early in the spring a pair of chickadees began carrying cotton out of this box. Day after day they worked industriously, but did not appear to make any use of the cotton. Finally it became evident that they were merely digging out of the cotton a hole for a nest, as most of the cotton taken out was carried to a neighboring pear tree and either thrown to the breeze or left hanging on the twigs. So the little birds continued to work day after day until they had hollowed out a neat white nest in the midst of the cotton. Then they lined it with a few threads, hairs and feathers, and the female deposited ten eggs, from nine of which young birds were afterward hatched and reared. As the box had a door that could be opened, the little mother could be watched from the kitchen a very few feet away. She seemed as interested in our housekeeping as we were in hers. When the young were hatched, however, she had no time to indulge her curiosity, for it required trips aver-

aging about two minutes apart during most of the day to supply them with food and so stop their gaping mouths. In the meantime another brood was being reared by another pair of birds in a box in the apple tree, some two rods away.

In 1904 an attempt was made to provide a dwelling place for the screech owls that occasionally were heard in the grove near by. These birds are believed to feed mainly on insects, mice, and other so-called vermin. A box, similar to the one in the illustration, was put up in a large pine tree about four rods south of the house. It was not occupied that season, but the next winter an owl visited it occasionally, and, as spring approached, a small gray owl might be seen some evenings at sunset, sitting in the doorway and solemnly looking over its hunting ground. The jays, robins, and chickadees soon learned the secret of the box and told it so that all the world might hear. A little later sticks, straws, and other rubbish might be seen protruding from the opening. Late in April I ascended the tree and found the little owl sitting upon her eggs. Soon the white, downy young appeared, and then the lining of the nest was embellished with the wing and tail feathers of several blue jays, one robin, and one red-winged blackbird. Otherwise, however, the owls did not appear to trouble the smaller birds, but rather protected them by killing the blue jays which formerly ate their eggs. I believe that rather more small birds than usual reared young in the neighborhood, although fewer chickadees were seen the following winter. The owls reject the indigestible portions of their food, which are thrown out through the mouth, and may be found upon the ground about their nests or roosts, in the shape of pellets, composed mainly of bones wrapped up in fur or feathers. In order to determine the character of their food, I gathered all the pellets that could be found, and in only one instance were there any remnants of a bird (a robin, of which we have a surplus). On the other hand, there were found the bones of deer mice, wood mice, field mice, and mole shrews, the remains of from one to three of these little animals being found in each pellet. While this experiment has not yet progressed far enough to prove that the owls are desirable tenants, it seems probable that they much more than pay their rent. Five young were raised to maturity last year and sent out into the world to earn their living, as their parents did before them.



**SCREECH OWL BROODING YOUNG. (FRONT
OF BOX REMOVED.)**



YOUNG OWLS IN NESTING BOX.

)

The work of attracting birds about the house and domesticating them there is of inestimable value to children as a source of amusement, as training for the observational faculties, and as an object lesson in kindness. This may be illustrated by the story of a bird box that was put up by the little son and daughter of Professor C. F. Hodge, of Worcester. Alone and unaided, they set up a pole, fastened a box upon it, and later, when the young birds, which were reared in it, were deserted by their parents during a severe storm, the young people fed and reared the little ones. These birds became so tame that when called, they would come to be fed long after they could fly and had left the residence of their human friends. When we teach our children thus to love, protect, and feed the birds, it may be possible to so increase the bird population that those insects pests on which they feed, will give us little trouble.

DISCUSSION.

Secretary BROWN. You intimated in your lecture, Professor Forbush, that you had seen signs of the brown-tail moth in Connecticut. We are very anxious in Connecticut in regard to that insect. In fact, we live under the shadow of a great fear that the gypsy moth and the brown-tail moth will invade our territory. Will you please tell the convention more definitely where and what the indications were of the presence of the brown-tail moth.

Prof. FORBUSH. I do not want to say positively, Mr. Chairman, that the brown-tail moth is in Connecticut. What I saw on the train was what seemed to me to be indications of its presence, but a man traveling at the rate of thirty miles an hour cannot be sure. What I saw was simply a few leaves wound up into a small web about so large, sometimes larger and sometimes smaller, and that is the usual way in which the young caterpillars pass through the winter, and then the minute the foliage starts up in the spring, they start out and commence their work. I think I saw signs of it within two or three towns of yours here, but, of course, it may have been something else.

Secretary BROWN. There is one other question. "Have the birds lessened the quantity of gypsy and brown-tail moths in Massachusetts?"

Prof. FORBUSH. Unfortunately, we have in this country a plentiful supply of English sparrows, and they have a tendency to drive other birds away. Just at the time when the English sparrow began to drive our other birds out, these moths appeared. We had comparatively few birds in that section, so that the moths have increased. They have become so many in fact, that nothing has stopped them. You are going to have them right here. You will have the brown-tail moth within five years, and the gypsy moth within ten years, and you might as well understand it and get ready for them. There is no question about it. You want to do everything you can to stop these insects because they are going to be the worst pest you have had to deal with in years. The gypsy moth preys on all kinds of vegetation. It will kill your pines, and get into your houses, and is a nuisance of the worst order. I know a man who five years ago thought the gypsy moth was not going to amount to much, and he did not want anything done on his property. I went out to see him the other day. He said, "I have lost two-thirds of my apple trees, and have suffered much damage on other trees and shrubs." That is the way it goes. One gentleman I know of has spent over fifty thousand dollars on his place in trying to stop these insects. He is still working. We have got some parasitic natural enemies of these creatures. Of course, they can be cultivated, but until they can be to a sufficient extent, we have got to fight. You will have them here just as sure as there is a God in Heaven, and you have got to do everything that you can to fight them.

Convention adjourned until 10 A. M., Thursday, December 14th.

MORNING SESSION.

December 14, 1905.

Music.

Convention called to order at 10 A. M., Vice-President Seeley in the Chair.

The PRESIDENT. We have a few questions that I will ask the Secretary to read.

Secretary BROWN. You remember that poultry was the prominent subject discussed yesterday. In the box I find this question, "Do rats trouble when self-feeders are used? And if so, what can be done to get rid of them?" Is there any poultryman here who can answer that question?

The PRESIDENT. Is there any other man that knows what to do with rats when they get to eating up grain and doing mischief, and all that sort of thing?

Secretary BROWN. Mr. President, I know what I do. I get some arsenic and mix it with grated cheese and a little flour. I put it where nothing else can get it, in one of the buildings outside, and then I put some water near so as to accommodate the rats. They like the cheese and they do not feel the arsenic until it is too late. They naturally go to the water, and the water gives them a comfortable exit.

Secretary BROWN. There is one other question that interests truckmen: "Has anyone had experience in using a tobacco setter for settling cabbages and other plants?"

Mr. MITCHELL. In the next place to where I am now living is a large cabbage shipping station, and they are using the setter entirely for setting cabbage plants. I have asked what kind of service they gave, and am told that the plants live even better when set by the machine than you can make them live when set by hand.

Secretary BROWN. Here is a question for stockmen, or those who own large barns: "Is it wise to have all of your barn buildings under one roof?" Those that have encountered

fires lately may have a word to say on that. Perhaps Mr. Patten can give us some information.

Mr. D. W. PATTEN. I do not think, Mr. Secretary, if my barns had been so situated I would have had any buildings to-day, but being scattered somewhat, I was able to save the larger part of them.

Prof. SHAW. Mr. Chairman, I would like to say a word on that question. Is it possible to be as economical in labor by having barns separate as it is when they are under one roof? Suppose that buildings in one case are separated, and suppose in another case that they are under one roof. Is it possible to have as much economy in the labor of feeding when the buildings are separate as when they are under one roof?

The PRESIDENT. I think not.

Secretary BROWN. I suppose the whole question turns on whether the danger arising from having them under one roof is more than counterbalanced by the extra labor where the buildings are separate.

I would like to ask Mr. Averill if he does not think it is well to have more than one barn where you have diseased cattle quarantined with tuberculosis or anything else of a contagious nature?

Mr. AVERILL. I would say it is highly important to have a place where animals can be quarantined and isolated away from other animals in the herd. It is not necessary that that should be done in an outside building, because after having an animal sent to quarantine the stable or place occupied by the animal in quarantine can be thoroughly fumigated, cleansed, and disinfected.

The PRESIDENT. You say that they may be in the same barn?

Mr. AVERILL. I think if people would exercise due caution about traveling between infected and uninfected animals, so as not to carry the infection when passing from the stable

where the animal was in quarantine to the others, it would be safe enough to keep quarantined animals in the same barn. I would say, however, that if you have a separate building there is an added risk of fire and loss by lightning. If you have buildings scattered about the farm you are more liable to have buildings destroyed by fire and lightning.

Prof. SHAW. May I ask the gentleman if the risk would not be less by keeping the infected animals in separate buildings than in the same building with the other animals?

Mr. AVERILL. There would be less risk in keeping them in neighboring buildings. I am free to admit that if an animal was kept in a separate building and was cared for by a separate attendant there would be far less risk of further infection and secondary cases. We have had and are having at the present time scarlet fever in my own town. The school is closed. It broke out in three families. In each of these families there were not less than seven children. Now if those patients were quarantined in the same building with those children, in two out of three cases I am sure there would be no secondary cases. It looks to me, Mr. President, that we do not need, in treating cases of contagious disease among cattle, to go to that extent, of course, the foot and mouth disease excepted. If scarlet fever patients can be isolated in a house where there are six or seven other children I think that the same precaution observed in the treatment of animals would undoubtedly have a similar effect.

Prof. SHAW. I would like to ask the gentleman's opinion about this: Take a tuberculous cow, for instance, kept in the same building with cows that are not tuberculous, and in the same part of the building, only in a box stall, but not a tall box stall, or where the partition does not go up to the ceiling. I am asking about this for this reason. I was asked to visit the station at Geneva in the summer. I went there for information about tuberculosis. They had been conducting some experiments, and they took me to a stable where they

had a tuberculous animal put into a stall by itself. The stall did not extend to the ceiling. There were other animals in that room. I thought, Mr. Chairman, that that was a queer thing for an experiment station to do. I would not want them on my own barn, but I would like to know the opinion of this gentleman on that subject.

Mr. AVERILL. Why, as I said before, Mr. President, if an animal can be quarantined so as to be entirely separate from the rest of the herd there is, of course, less danger. A box stall, such as Prof. Shaw suggests, should afford protection to the other animals in the herd, but it is not absolutely perfect. We know that because a farmer that has a tuberculous animal in his herd keeps it among his other animals until, perhaps, it dies. It does not necessarily follow that there will be any secondary cases. On the other hand, there may be some that will have the disease. If the owner has a good spacious box stall to put that animal into, the danger to the other animals will be very much less, but the danger would not be entirely removed. Everything that can be done by the caretaker or owner to remove danger, is, of course, an advantage, but the only way to be absolutely free from the danger of infection or inoculation is to keep the infected animals entirely apart.

Secretary BROWN. As pertinent to the subject to be discussed this morning, I want to ask permission to read a few lines from the *Hartford Courant*: "Wisconsin, by not applying practical forestry work, will soon suffer, in the practical exhaustion of her pine lands, the penalty of wastefulness. The figures of statisticians of the Department of Commerce and Labor show that the pine shipments for the first eight months of this year were almost as great as the corresponding period of 1904 and greater than 1903, but notwithstanding this seeming abundance it is a question of drawing upon the few remaining large tracts which are owned by the lumber companies and which are being cut off very rapidly. The development of scientific forestry seems to have come too late

to save the Wisconsin pineries, but they afford an excellent object lesson for other states." This morning's paper seems to be very timely in view of the subject which we are to discuss at the opening of this morning's session.

The PRESIDENT. You will notice on your programs that we are to have an address on "The Work of the Forest Service for Farmers." That is one of the things that is coming to be very important to farmers, and I am glad to introduce to you Mr. Herbert A. Smith, a native of Connecticut, but now of the U. S. Department of Agriculture, Washington, D. C., who will speak to you upon this subject.

"THE WORK OF THE FOREST SERVICE FOR FARMERS."

By DR. HERBERT A. SMITH, Washington, D. C.

Mr. President, and Ladies and Gentlemen:

I am indeed glad to come back here and talk to the people of Connecticut about our forests, and especially so from the fact that this very region is connected with my earliest memories. From the time I was four years old until I was nine I lived within twenty-five miles of here, and always these woods and hills have held a place very close to my heart.

The Forest Service is, as perhaps you know, a new name lately given to an old organization, formerly known as the Bureau of Forestry, a part of the Department of Agriculture at Washington. Up to a little less than a year ago the Bureau of Forestry held a somewhat singular position. It was the recognized authority in this country in all matters connected with conservative forest use. It was the only part of the Government which had in its employ trained foresters, and it was the one place to which other Departments of the Government controlling forests had to apply when they wished any information and guidance in the management of their forest land. At the same time there had developed in this country, as a recognized part of our National policy, the policy of setting aside and maintaining forest reservations. A year ago the National reservations, set aside under both Democratic

and Republican presidents, embraced a total area of over sixty million acres of land. Yet notwithstanding that the Bureau of Forestry had all the technical knowledge necessary to handle these lands in the proper way, it did not have under its control one single acre of forest land in the whole United States.

Now Congress has changed all that. The Bureau of Forestry has become the Forest Service, because evidently its most important task is going to be the management of that part of the national domain in which forests are to be maintained and used for the benefit of the people. During this last year the forest area in reservations has increased to a far greater extent than in any previous year, for President Roosevelt is a great supporter of the reserve policy, because as a clear-sighted and far-sighted man of affairs he recognizes the vital importance of this question to the people of the country as a whole. One hundred million acres of land are now under the administration of the Forest Service. That is a greater extent of territory than all New England, New York, and Pennsylvania. It is to be maintained in perpetuity for the use of the people, for the preservation of the timber supply which is absolutely necessary for them and for the protection of water supplies, especially necessary in the West. This work of administering the reserves will ultimately be the main work of the Forest Service, and hence its change of name.

At the same time, the present work of the Service is broadly along the line of all the work of the Department of Agriculture — the work of making the land of this country contribute all that it can to the welfare of the nation. Idle land or waste land is not helping us; it is not mere expanse of territory, but land which is being well used, which makes us powerful and prosperous. Our forest lands, on the whole, are not being well used. A forest may be cultivated just as much as a plowed field. A wild forest, even a wild forest in a state of nature, is not equal to a cultivated forest in point of its ability to contribute to the welfare of mankind. We have treated our forests generally as purely natural resources, and have taken their timber without any effort to keep up the supply. Take the pine forests of the Lake States. We have used them up. They have contributed tremendously to the upbuilding of the country. In every little village of New England and in

every farming community of the Middle West, the benefit of cheap lumber from those forests has been felt. It has gone to build farmers' houses and barns, it has gone to build factories and workingmen's homes. But in the future we shall not have these forests as sources of timber supply, and we shall all be the worse off on that account. If instead of cutting those pine forests off, with tremendous waste in some instances, they could have been cut under such conditions that a new crop would have come up to take the place of the old, what a benefit it would have been to the nation! On land which is now desolate and for the greater part worthless, we should then have a supply coming on against the day of our need which is certainly approaching.

I wonder if you appreciate at all how much agriculture as practiced at present owes to science, or to what an extent the common, everyday practice of today is indebted to the scientific researches of the past. I sometimes think that if we could look back upon the practice of our ancestors when they first came to this country, it would seem to us hardly less barbarous than the method of culture employed by the Indians in raising their small crop of Indian corn. In England, at the time when the colonists came to this country and practically through the eighteenth century, farming land was for the most part held in common. This land was divided into three classes. First was the meadow along the stream, or grass land, in which each man had his portion assigned up to the time when the grass was cut, after which it became common again for all the cattle to graze upon. Next above this was the plow land, of which one-third was sown to wheat, one-third to peas, barley, and a very limited range of other crops, and the third was fallow. The third to be left fallow was changed every year, so that any given piece of land was cultivated only two years out of three, and then allowed to rest for a year in lieu of fertilizing. Individual allotments changed every season. No man could improve his land under such circumstances, because he did not hold it permanently, but only in turn. All implements were home-made. The cattle and sheep were pastured on the "waste," or higher land, which was never tilled, and which furnished wood material as well as pasture. Weeds were abundant, manuring unknown, improvements discouraged; in every way the system of agricul-

ture was primitive and wretched. Agricultural progress was necessary before a larger population could be supported, and great parts of England were waste at that time which are now highly productive, thanks to the improvements which the study of scientific farming introduced. This kind of study, which virtually adds to our territory because it adds to the supporting power of our land, is what the Department of Agriculture exists for.

Now our way of treating the forests has not advanced so much over the method of those early days. We leave it largely to take care of itself. We oftentimes turn our cattle out to pasture in it. We do not attempt to use the land to its full power. Farmers' holdings are small individually, but in the aggregate they are of tremendous importance to this country. Something like two hundred million acres of land — upwards of one-third of all the forest in the United States — is held in farmers' woodlots. It is a work most emphatically of national importance to see that this land is well used, that it yields its fullest contribution to the individual and to the nation, that instead of being only half as productive as it might be it shall have as many trees growing upon it as it will properly bear, and of the best possible kinds, and that these shall be utilized in the best way. The needs of this country for timber in the future are going to be far more pressing than you probably realize. Lumber prices have risen steadily during the past century, and rapidly in the latter half of it. Good timber in the woodlot, if it is not deteriorating, is exactly like money in the savings bank. Interest is accruing on it irrespective of the growth, and the woodlot is in fact a most excellent auxiliary savings bank for a farmer. He has the equivalent of money in it. He can get more in it. He will not have to withdraw money from other purposes in order to do this. He can get more money in his woodlot, and at the same time use it for the production of ties and cordwood which he can sell, as well as for the production of fuel for his own use. That is to say, he can use it under such methods that the woodlot timber will be getting better all the time. The ordinary way is just the opposite. The forest is allowed to deteriorate through the use of careless methods by the farmer. When he goes into his forest he takes his axe and cuts the best trees, or those which are the easiest to work up.

It does not occur to him that he is leaving inferior trees, which he will not want, to take the place of those which he removes. In other words, the weed trees, as the foresters call them, are left — the useless trees, or trees that crowd out and displace good trees. The result is very much as though the farmer went into his garden and kept pulling his vegetables and allowing the weeds to grow up and fill the ground. The work which the Forest Service is trying to do for the farmer is to teach him to cultivate his woodlot, to learn about his trees, and about the different requirements of different species, and to make the land yield its fullest possible supply.

The question of timber supply is a matter of vital importance to the entire country. The railroads, for instance, the means of transportation, are absolutely dependent upon the forests for their ties. Every railroad tie laid in the track — and engineers have found no substitute which they are willing to accept in place of the wooden tie — every tie laid in the track all over the country requires two trees growing in the forest in order to keep it there.

The present price of railroad ties of the best quality bears no proportion at all to the nearness of the exhaustion of the supply, and the railroads know this very well. Some of the most important railroads in the country are going into the business of raising ties for themselves because they fear the time may come when they cannot buy the ties that they need. But tie production is going to be one of the most profitable employments of the woodlots. White oak ties are the ties which the railroads prefer, and I suppose that the supply of white oak ties is going to be substantially at an end before very many years have passed. The white oak is too good a tree; we can not afford to use it for ties. A white oak tree which can be bought in this country in the region of its best growth for a dollar and a half, in Germany would bring perhaps a hundred or a hundred and fifty dollars; sometimes even two hundred dollars are paid for a single tree. An acre of white oak is sold sometimes in Germany for over two thousand dollars, and it is not at all unlikely that our prices will, before very many of us are old men, be but little below the prices of timber in Germany.

The capacity of the country to consume timber is almost beyond any credible form of statement. You may think that the substitution of other materials will diminish the need of

lumber. Quite the contrary. Our cities are built of stone, brick, iron, and concrete, but more wood goes into our cities for construction purposes today than in the days when they were built entirely of wood. Our steamships are built of iron; but more wood goes into ship building now than formerly. And so on through one industry after another. The cooperage industry, which consumes large quantities of oak, recognizes that its existence is imperiled by the scarcity which it has itself created. The amount of lumber that is consumed for barrels of all sorts — oil barrels, sugar barrels, molasses barrels, beer kegs, whiskey barrels, flour barrels, apple barrels, and then for lime, cement, truck, and almost every other kind of article, is enormous in its total amount. The coopers will have to turn to the woodlot as one of their main sources of supply. So also in the case of mining, which consumes even more timber than the railroads, the demand upon our forests is very great. The miner must have timber to prop up as he goes along. His demands require provision for the future. And so with every great industry; all are consumers of timber, and will suffer when timber grows scarce and dear.

To meet this need the farmers must do their share. What is the method? What is the wisest course for the farmer to take who wishes to make the most out of his woodlot? Well, he must begin by remembering that he wants his land fully stocked. If he has an old pasture that is coming up slowly to forest growth, on which the red cedar and the white birch, or gray birch, as it is more properly called, is coming in, he ought to help nature along. Here is probably an opportunity for him to do some planting with very profitable results, and although he may not himself live to cut planted timber, it is not necessary in order that this savings bank should be helpful to him that he should wait until the timber is full grown. It is certain that well-timbered land is going to be salable land, and especially that which has a good stock of young timber on it. It is going to be salable at a much better price than land which has received no care.

Then the farmer must look out that as he cuts his trees he selects them in such a way as to benefit the forest and to provide for another generation. The branchy, wide-spreading tree, the crooked tree, or a tree of a kind which is not likely to prove salable, is the best kind for him to cut down when he

is getting out his supply of firewood, because he thus makes room for better trees. As he cuts he wants to look about and see which are going to take advantage of the cut. Perhaps he will see that he had better cut some young sapling or some half-grown tree which is ready to push into the opening he will make, but which he will not want. He must pick the trees that he wants left, and provide for them. There is a very striking picture in the back of the room, of a chestnut tree which had grown seven inches in diameter in thirty-four years. The rings showing the growth which the tree made are very close together for these years; the tree had been too crowded to have a fair chance. Then the trees about it were cut sufficiently to give it an opportunity, and in the next eight years it doubled its diameter. In other words, it made four times as much wood on the same length of trunk in eight years as all that it had made in the preceding thirty-four years — since the ratio of volume increase is the square of the ratio of diameter increase — besides the increase due to its greater height. You can see in the picture the wide rings which are the indication of this rapid growth. So that thinning is an important means of making your timber add to itself at the fastest rate.

When the farmer goes in to cut he is very likely to lay about him with the axe pretty freely. The little stuff in his path is regarded as brush, and is cut out of his way without much thought that it has any value. Very likely just the trees that should have grown up are thus sacrificed, and the next cutting may be set back a dozen or fifteen years. You all know that the growth of sprouts, which start from the stump after cutting, is much more rapid than the growth of seedlings. This is because the sprouts do not have to establish a root system of their own, but are virtually branches of an old tree which has been pruned back to the very ground. Consequently, in this region of second-growth hardwoods, almost all of which sprout from the stump, by far the largest volume of wood can be secured under a system of sprout, "coppice," management. But it must always be borne in mind that the vigor of sprout growth declines as the root systems age, for the sprout is itself, as has already been said, only a branch. Consequently new seedlings are needed in a sprout forest to replace the enfeebled stock.

So when the farmer begins to cut in his woodlot he needs to remember that a small sapling which has grown from seed and is well located with respect to an opening is valuable out of all proportion to its size. And he wants to remember also that it is highly wasteful to cut a tree, even when it has reached a fairly good size, if it is still growing vigorously, unless, of course, it is a tree which is not wanted. A 12-inch tree puts on twice as much wood to each foot of trunk in growing another inch as does a 6-inch tree. To cut a tree which is six or eight inches in diameter is like drawing your money from the savings bank just before interest day. You lose the benefit of the earning power that the tree has been gathering.

There is such a thing, however, as having too many trees, though as a rule the danger is that your land will be understocked rather than overstocked. That chestnut tree to which I referred a moment ago, which was thirty-four years old before it really began to grow, should have made, I suppose, a tree from which three ties could have been cut in something like that age. A white oak will require from forty to fifty years, I believe, in this region, under favorable conditions, to make a three-tie tree. I do not wish to go into this too far, because it is a matter for your State forester to inform you on rather than for me to discuss, but I presume that the fact of the greater rapidity of growth of the chestnut will make that generally the best tree to grow for tie purposes in this State. That is the sort of thing that the farmer must ask himself, or must ask the forester. He must inform himself as to what tree is going to be the most profitable in the long run, and also what the requirements of the different kinds of trees are. One tree will grow in a situation where another will not. It is necessary to know about each kind, and how to give it the conditions which will make it grow the best. The farmer must study his forest.

Now I have said something about what the forester calls thinnings, and what he calls improvement cuttings. The purpose of thinnings is to improve the growth of trees already on the ground, and thinnings are, therefore, naturally made in rather young timber, and yield only small stuff. Improvement cuttings, on the other hand, aim primarily at making place for new growth by the removal of trees which are overmature, crooked, broken-topped, or otherwise defective, or which are of the less desirable kinds. The man who wants to increase the

productiveness and value of his woodlot must not expect to get something for nothing. It will pay him to cultivate his land, woodland as well as plowland; he will get more from it; but he cannot cultivate without putting in labor. When he begins to make thinnings or improvement cuttings he must not expect to secure his cordwood as easily as if he picked out his best and biggest timber and cut it clean, or cut all that was good and left the bad. You cannot eat your cake and have it too; or rather, you cannot eat your woodland goose and keep on pocketing future golden eggs. The difference is between gathering your capital, on the one hand, and letting it roll up interest on the other. If you can make the cultivation pay for itself in the incidental product of wood, you are not doing badly. If you can make your improvement cuttings more than pay, it is very much like finding money. You will then, in fact, have kept all of your cake, and had a taste of it too.

Yet the forester, as a practical man, ought to be able to tell you how on occasion you can harvest your timber at a reasonably low cost and at the same time provide for a speedy renewal of the forest. It is hard to give general prescriptions in such matters; ordinarily the Forest Service tries to answer requests for information from individual owners by sending an agent to make an examination and give advice on the ground. But I believe that in this region as good a method to recommend as any I can give you is what the forester calls the group method. Select a spot, or several spots if one will not supply what you want to cut, where your forest crop is ripest—possibly overripe; and clear, with due care of course for young growth, a hole in your forest, taking care that the diameter of this hole is not more than twice the height of the surrounding trees. Another year, or better several years later, after you have opened as many holes as you think advisable, but not until after seedlings have had a chance to establish themselves wherever they are needed, you can begin to widen the holes by cutting in concentric rings about them, and this can be continued until the whole area has been cut over. By this method you can get an entirely new seedling forest, if you are cutting trees which do not sprout, or if you have an old or deficient sprout forest you will fill up the blanks and get supplementary seedlings under way.

Bear in mind, however, that if in any one year you cut more wood than grows on your whole woodlot in that year, you have diminished your principal, and if you cut over your whole area before the area which you cut first has had time to grow to maturity, a period will have to follow during which your woodlot will stop paying dividends.

The farmer is in a better position to care for his forest and make money from it than other owners, because he can do this work in the woods at a time when there is not much else to be done on the farm—that is, in the winter. If he takes an interest and is observing, if he goes into the woods with his axe and notices what is happening, and thinks what he wants and takes his measures accordingly, he will soon learn a good deal about his forest as well as make a decided difference in its value.

The work which the Forest Service is doing for the farmer is perhaps better appreciated in other parts of the country at present than it is generally in the East. In the West the farmers' need in a large part of the country is for water, and the farmers there now recognize that the first and most important means of securing water is through forest conservation, not because forests make rain but because forests enable the farmer to get the benefit of what rain does fall, through the storing power of the forest. I was very much struck last winter to hear a Congressman from western Kansas say in Washington, at a very important meeting of forest users, held under the auspices of the American Forestry Association, that in his Congressional district alone—that is to say, in a region having a population of about two hundred thousand people—there was more arable land than in the entire kingdom of Japan, if they only had water for it. Japan supports a population of forty millions. Japan is a first-class power, about on a par with England in population, and a little ahead of France. We have room within our confines for empire after empire, but the development of these western lands depends very largely on irrigation. Irrigation and forestry are so closely connected that one can not exist and do its full work without the other. The most important work of the forester in the West is to conserve the water supply so as to hold the rain as it falls and let it run down little by little from springs that flow all the year, instead of rushing from the hillsides and moun-

tain slopes and sweeping down in destructive floods. And so this work which the Forest Service is doing for the farmer is appreciated in the West as of tremendous importance to its people. That work is important for New England too, for every farmer in the West means a larger demand for the manufactures of the East. New England is essentially a manufacturing district. It must have a market for its manufactures, and is, therefore, directly interested in this matter of irrigation in the West.

Again, the West is largely a grazing section. A map was prepared recently in the Forest Service showing the extent of the Western range. This range, you know, is for the most part public land. That map, which showed in green the portions utilized for grazing, looked as though pretty nearly all the West from east of the Rocky Mountains to the Pacific was green, as though it was all grazing land. Now a very large part of this vast livestock industry depends on the forest reserves for summer pasture. In its efforts to make the reserves yield as much forage for the grazing industry as is possible without injury to the forests themselves, the Forest Service is working for the agricultural interests of the country, applying here again the principle that every kind of land should be put to its most profitable use.

Before I leave this subject I want to say a word about the use of our forests for pasture here at home. If you are pasturing your woodlots you are almost certainly decreasing to a very considerable extent their productive capacity. Cattle will graze upon the young seedlings and the young shoots as they come up. They will break them down, and they will trample the ground and make it hard so that the seeds when they fall will not take root easily in it. Oftentimes you may notice, as you drive through the country, woodlot pastures in which there are only old trees. It is, therefore, perfectly evident when you think of it that when once those trees are cut or dead the forest will be like a stream which has been turned aside near its fountain head. It passes by and nothing is left. So I say to the farmer, decide what your land is most valuable for. Trees and grass do not get on well together. They are mutually antagonistic. Grass is not good for the forest, and trees are not good for grass. To a very moderate extent you may perhaps pasture in your woodlot, but you must be con-

stantly on your guard that grazing does not go far enough to affect the condition of the forest. It is just as well if you can keep the woodlot absolutely separate from the pasture.

And then, of course, you must keep out fire. Fire is the worst foe of all to the woodlot. A young farmer was telling me not long ago how near his house there was a very dense grove of young saplings. "You could not see into them at all," he said. "If a cow got in there I could not find her. But last spring, when the leaves were dry, I touched a match to them, and the fire went up like a flash." Now perhaps it was best for him to make that land into pasture, though I doubt it very much. I do not believe, however, that he had ever given the question whether the land would be better under forest or for pasture a moment's consideration. He simply looked upon that young growth as brush. If he had left a five dollar bill lying around and a little child had touched a match to it, and it had "gone up like a flash," I think he would have found some speedy way of making a very distinct and positive impression upon that child of the fact that he had done a mischievous and wasteful thing. Yet, from my point of view, he had probably done just exactly that kind of a thing himself. Fire must be kept out if we are going to have our woodlots amount to anything at all.

The farmer who will bear these things in mind, who will seek for information, who will make his forest produce all that it is capable of, will not only do a good thing for himself and his family but will also be doing something toward the public good. In making his own land most useful he will be helping to make and keep this country great, rich, and prosperous among the nations of the earth.

The PRESIDENT. I do not trouble myself much about alfalfa, but I would like to know more about it, and we have a gentleman here who I think has been sitting up nights with the problem, Dr. Jenkins, of the Conn. Agrl. Experiment Station, New Haven, and whatever he tells us is sure to be well worth hearing, so I am going to introduce Dr. Jenkins to say something about alfalfa.

ALFALFA IN CONNECTICUT.

By DR. E. H. JENKINS.

Alfalfa is no new thing in Connecticut. It has been tested now and then and here and there in the State for twenty-five years or more with no success, so far as I can learn, until very lately.

The facts that it is a success in the West, that if it could be grown here it would be a great boon to all our dairymen, and that comparatively recent study and observation have shown reasons why earlier tests have not succeeded and how we may hope to succeed where we failed before, have caused a great revival of interest in it.

The Station has made a number of careful trials with it in various places, and the aim of this paper is to notice some things which must be done in order to get a good stand of alfalfa and incidentally to show that in this State, at least, it is a difficult and painstaking matter to start the crop. It is no such easy thing as if often represented.

THE MERITS OF ALFALFA.

About its yield and its fodder value little need be said, for they are constantly emphasized as chief reasons for its extensive use. From fields of more than an acre, where the alfalfa had been three years on the land, an average of 13.8 tons green weight per acre were harvested at the New York Station, containing over 1,100 pounds of protein.

In New Jersey the yields on carefully measured fields have ranged from 18 to 24¾ tons of green matter, or 4.4 to 7.2 tons of alfalfa hay per acre.

The Colorado Station reports an alfalfa crop which yielded about twice as much dry matter as a corn crop on an equal area and similar soil, and four times as much protein. The corn crop was called a fair one, yielding 14 tons of green fodder; but this is in a country where, I imagine, alfalfa will grow much better than with us and corn will not yield as well.

The Canadian farmers report from 12 to 24 tons of green fodder, or 3 to 6 tons of hay.

The figures which I have here, but need not read in detail, show that a moderate crop of alfalfa, 18 tons, green, contains 1.7 times as much protein as 28 tons of green corn fodder, and four times as much as three tons of hay of good quality.

Alfalfa hay is a richer feed than clover hay, containing as much digestible protein, pound for pound, as wheat bran. One of our Connecticut correspondents says "My horses would leave their grain to eat it and the hens would do the same. I shall keep at it till I make it go."

If alfalfa can be grown and cured here, its value to our farmers and dairymen will unquestionably be very great.

AVERAGE COMPOSITION OF ALFALFA, CORN FODDER,
CLOVER HAY, AND MEADOW HAY.

	Alfalfa, green	Corn Fodder, green	Red-Top, green	Alfalfa Hay	Clover Hay.	Fodder Hay, Corn, mixed field Grasses cured	
<i>Percentage Composition.</i>							
Water,	71.8	79.3	64.8	8.4	15.3	42.2	16.0
Ash,	2.7	1.2	2.3	7.4	6.2	2.7	4.6
Protein,	4.8	1.8	3.3	14.3	12.3	4.5	6.4
Fiber,	7.4	5.0	9.4	25.0	24.8	4.3	29.9
Nitrogen—free extract, .	12.3	12.2	19.0	42.7	38.1	44.7	41.0
Fat,	1.0	0.5	1.2	2.2	3.3	1.6	2.1
	100.0	100.0	100.0	100.0	100.0	100.0	100.0
<i>Percent. digestible.</i>							
Protein,	3.6	1.3	2.3	7.6	6.5	2.6	3.6
Nitrogen—free extract, .	11.4	11.8	20.5	37.8	34.9	33.3	42.7
Fat,	0.4	0.4	0.7	1.3	1.6	1.1	1.0

Besides yield and richness, alfalfa has other great merits. At its best it is permanent on the land. There are very few meadows in the State which do not need to be taken up every five years, at least, and re-seeded. Alfalfa is claimed to keep up its productiveness almost indefinitely, only needing perhaps occasional top-dressings of phosphates and potash salts.

It is an excellent soiling crop; the first cutting being ready somewhere between the middle of May and early June, and two or three other cuttings follow until the 15th of September or later. I believe that if we introduce it here this will be its chief use and its best use at first and while it is in the experimental stage.

We all know that to cure clover hay properly, so that it is not so dry as to lose its leaves and its value in handling, nor so wet as to heat too much and spoil in the barn, is no easy matter in our New England weather.

The same is true of alfalfa, all the more because of the greater burden of the mowing. It is not quick to dry, but if too dry loses its leaves like clover and with them a large part of its value. Rain on the nearly cured crop spoils it. It must be cut too, when ready; for the stalk gets woody very quickly as it comes into bloom. We have much to learn about making clover or alfalfa hay. Most of us, I think, err on the side of too much drying. If we can get in clover or alfalfa without dropping any leaves, pack it down well in the mow, close the barn and have it heat a good deal, without fire-fanging, we shall be sure of good feed.

At the West, in a dry climate, where the praises of alfalfa are chiefly — and with most reason — sung, this matter of making hay is, by comparison, simple, for there is no danger from rain and it cures much more safely in the cock than here.

For these reasons, I say, a successful alfalfa culture depends firstly on our ability to get and to keep a good permanent stand, and secondly on learning how to house it for winter use.

ALFALFA IS A CROP TO HARVEST, NOT TO PASTURE.

Under the best conditions, when well established, cattle may be pastured on it lightly. If they feed too long on it they will bloat, as on clover, and if they eat it too closely, as sheep are likely to do, they may damage the stand permanently. It is very hard to patch an alfalfa field by re-seeding the thin places. The new-sown plants never get vigorous and fill the gaps.

ALFALFA IS A NITROGEN-GATHERING CROP.

So much has been said too on this point, both of alfalfa and of all the cultivated legumes, that any more words may seem quite unnecessary. But let us have our heads clear as to the facts. The crop contains each year very much more protein — of which the distinguishing element is nitrogen — than any of our cereals or hay crops. Yet it does not seem to exhaust or diminish the store of nitrogen in the tilled soil as they do, but rather increases its store, and yet keeps up its yield year after year, while cereals, if raised continuously, steadily decrease their product till they come to a certain minimum production which they can keep up for a long time perhaps.

A part of this difference between legumes and other kinds of crops may be explained by their deeper rooting; a part also perhaps by their stronger feeding capacity—their ability to assimilate forms of nitrogen from the soil which cereals cannot assimilate—to eat, let us say, what cereals cannot eat; and partly (and to my mind only partly) this nitrogen-gathering quality is to be explained by the action of those bacteria which live on the roots and in connection with the well-known “nodules” of the roots. It has been fully proved that alfalfa plants having these nodules with living bacteria, are able, in ways not fully understood, to get hold of the free nitrogen of the air in the soil and combine it in vegetable forms. This, other plants than legumes, with few exceptions, and as far as we now know, cannot do. This gives to alfalfa and other legumes their greatest agricultural value. They enrich the crop and, through the roots, stubble and crop residues, the soil itself with nitrogen, that most expensive element of plant food. This fact of the enrichment of the soil by legumes was well known a good while ago, and the practice of growing pulse alternately with a grain crop is immemorial in India. Such parts of the explanation as we now have it is quite modern.

I believe that Professor Atwater and Dr. C. D. Woods at Middletown were the first to give an absolute proof of the assimilation of free nitrogen by legumes under conditions which were beyond criticism, and European investigators chiefly have taught us what we know of the extent and the method of this assimilation.

It is not the only way in which soils gather free nitrogen. It is certain that other microbes, low forms of vegetable life, which are not connected with legumes, also gather it. A soil containing humus and not acid, under favorable conditions, will of itself gather a certain amount of nitrogen. What conditions favor this and how much nitrogen may be gathered by this means remains to be learned, and to my mind this is one of the most important questions regarding the maintenance of soil fertility which is waiting for solution.

But certainly the supply of free nitrogen which legumes furnish seems at present to be far greater and more rapid than that from other sources.

The raising of legumes is and has long been known to be a way of restoring exhausted soils, by increasing the amount

of humus, nitrogen, and perhaps also available mineral matters in them.

It needs to be remembered, however, that there is a limit to this nitrogen-gathering action of any legume. If a soil already contains a good supply of available nitrogen, a crop of legumes will not add to that supply from the air, but will live on the combined nitrogen already present in the soil. You cannot go on forever catching nitrogen in your "nitrogen trap," as some call it. The plant and the microbe have to be starved into activity.

REGARDING THE HARDINESS OF ALFALFA IN CONNECTICUT.

We have grown it for five years at the Station with no sign of winter-killing. Scattered plants of it still persist in our turf ten years after the patch of alfalfa was plowed up and cultivated. Here and there through the State I have found it thriving in headlands and fence corners from seeding of unknown date. But whether it will bear exceptionally cold winters without being ruined or badly damaged as a farm crop is more questionable.

I have seen a half-acre on very sandy land but in a moist place, which had yielded fairly well for seven years with almost no care. Another field of several acres on heavier soil yielded very satisfactory for a longer time, but was so damaged by the last two exceptionally cold winters that it was turned under to be re-seeded to alfalfa after a year's cultivation to subdue the grass which had come in. Of course, even rye is sometimes badly winter-killed, but to make alfalfa profitable we must hold it on the land for a term of years. Its value is largely in its permanence. The land requires special preparation for it, the crop needs considerable care, compared with other forage crops, during the first year of its growth, and the reward comes in the permanence of the alfalfa, which must yield two to four cuttings yearly of very valuable hay or green fodder for a term of years with no more care than a permanent meadow, if it is to pay. It has been grown long and successfully in the province of Quebec, in Canada, and it is now grown in the British possessions north of us from the Atlantic to the Pacific, and is stated to be the staple forage for winter feeding in the drier parts of British Columbia. Yet, on the other hand, Fletcher, of the Ontario Experimental Farms, says that

the attempts to establish it as a regular forage crop of Canada have not been very successful.

In New York, reports from 86 growers of alfalfa showed that in a very severe winter 67 per cent. of the crops were more or less damaged and 33 per cent. were not. The damage was most common on heavy lands.

A small patch of Turkestan alfalfa on the Station grounds, drilled in in the spring of 1904, in a rather exposed situation, and which grew feebly that year, though kept clean of weeds, was given a light mulch of stable manure in the late fall and came through the very severe winter of 1904-1905 with absolutely no damage and did extremely well this last summer.

I believe that alfalfa will stand ordinary winters in most parts of this State with the little mulch that the fall growth gives it, that it will stand very severe winters if covered with snow, but may not if the ground is bare, and that a light mulch of long manure in the early winter is a desirable thing as a sort of insurance against winter-killing. It also greatly favors the increase of the bacteria of the soil on which the success of the crop depends, and in this way, as well as a direct fertilizer, pays for itself.

We have had trouble and, I believe, if it is generally grown there will be general trouble during the winter from the attacks of field mice, especially where it is under deep snow or other heavy mulch. The mice are fond of the large roots and eat out their crowns, thus killing many of the best plants.

It remains to say something about the fitting of an alfalfa field and its care.

A very erroneous impression has been widely spread lately regarding the possibilities of alfalfa culture. Magazine articles regarding the artificial inoculation of land and the advertisements of firms who offer inoculating material have given the impression that very recent discoveries had made it possible for the farmer, simply by inoculating his field with a laboratory preparation, to ensure success with almost any legume crop, enrich his land, and at the same time get large crops of very rich fodder. In short, to sit still and get rich; to get a good deal for nothing. This may work for a time in life insurance, but not in farming.

The truth is that he *may* succeed with alfalfa if he is skillful and fortunate. But in this State, at least, as our experience

shows, he can only succeed with alfalfa by taking the greatest care in selecting his land, in fitting it for the crop, and in caring for it after planting. If he succeeds fully he will be very richly repaid for his work. If he does not make a great success he will make a pretty thorough failure.

In the first place, the very poorest land will not grow alfalfa. It has got to have a fairly deep soil without a hard-pan underneath. It cannot live in standing water for any length of time, nor will it endure drought.

A well-drained but not a very dry field is essential. If not naturally a lime soil, a heavy dressing of lime in some shape is required in the beginning, and a top-dressing of lime or ashes from time to time. 1,500 to 2,000 pounds of lime kiln ashes or of stone lime is not too much. Alfalfa is a lime-loving plant. Potash salts and bone may also be used when fitting the land.

Equally important is it to get the land as clear as can be of weeds. Alfalfa is sure to fail on weedy land. Once established and growing thriftily after the first year it will choke out weeds, but in the first summer weeds will easily choke alfalfa. If land is not clean in the spring, it will pay better to summer fallow and sow alfalfa in August than to invite failure on such land by spring seeding. August is a better time to seed than spring because the summer weeds slacken their growth from then on, while alfalfa thrives until hard frost.

A proper seeding is not less than 20 pounds, and I believe 30 pounds is better when not less than 90 per cent. of the seeds germinate. It is essential to get at the start a perfect seeding. You cannot mend or patch it later.

And lastly, as regards preparation of land — what about inoculation? To succeed with alfalfa the soil *must* contain the microbe, which by its housekeeping with the plant makes possible the fixing of free nitrogen. That is absolutely certain. It may be in the soil to start with, it may be introduced at seeding time by inoculation of the soil or of the seed, but in one way or another the particular nitrogen-gathering microbe which associates with this particular plant must be there, or the crop is doomed to failure.

Some soils naturally contain this organism apparently. At least, alfalfa sown without any intentional inoculation does

well from the start and develops nodules on the roots. In our Station garden this was the case.

Other soils, and, I think, most soils, do not have this organism in them and need to have it brought to them. In places where repeated trials with alfalfa have failed, the inoculation of the soil has been at once followed with a good stand.

As to the best way of getting this microbe into the soil, I believe the surest way is to scatter on it soil taken within a few inches of the surface of a well-established alfalfa field where the plants show abundant root nodules. One hundred pounds of soil is enough, sown over an acre and harrowed in with the seed, or any time within three months before seeding.

Equally successful in Illinois has been the use of soil taken from waste land where the sweet clover, melilot, grows abundantly. This plant is not uncommon on waste lands here in Connecticut; it is a nitrogen-gatherer, and the observations and tests of Dr. Hopkins have proved its value in inoculating alfalfa fields.

The cultures made as a commercial venture, which have been so widely advertised to "double the yield" with the statement that "you can be absolutely sure of a heavy crop of alfalfa the first year after seeding," cannot be recommended. Experiments indicate that they are worthless.

I have tried to give very briefly an idea of the merits of alfalfa as a crop, the work which is necessary to success with it, and not to hide the difficulties of its introduction.

We need to raise more leguminous crops than we do now, not more for the sake of our cattle than for the sake of our land. We need them as cover crops for the winter, to prevent washing and leaching. We need them as green manure in the spring, and we need them to lessen our grain bills. Cow-peas and soy-beans are used to some extent. Red clover is neglected. To my mind there is more chance of *general* success with red clover than with alfalfa.

I wish every farmer in Connecticut might have seen the fields at the Agricultural College at Storrs as I saw them before snow flew. They were certainly an object lesson in good farming. There was no bare ground in sight in the late fall. Every field was tucked up for the winter with a coverlet either of rye or, for the most part, as it looked to me, of red clover. There was no chance for loss of nitrogen from the soil by

leaching; there was rather the certainty of a gain. None of the land was lying idle.

But this is not a talk on clover. Alfalfa at present has the center of the stage. An acre of alfalfa, at its best, will certainly yield more concentrated cattle feed than any crop which we can grow. It is worth a trial by all dairy farmers, even those who have failed with it years ago, for we have new knowledge regarding the causes of failure and the road to success.

But this is the real point of this talk. Don't let us take the time to simply fool with it. Laying down an alfalfa field is like making a road. It requires skill and work. It is to last for years. Do it right then, or leave it alone. Choose the land very carefully; get it as clean of weeds as it is possible, either by a summer fallow or by a hoed crop which is kept specially clean; put on a heavy dose of lime; get seed of which 90 per cent. will sprout, preferably from unirrigated western seed farms; inoculate with soil from another alfalfa field or from a patch of sweet clover; if weeds are abundant, clip the field five or six inches from the ground as often as needed to keep them down; and if the stand of alfalfa is thin and the weeds rampant, be prepared to turn the piece under and seed again between the first and fifteenth of August.

Every one of these points is quite essential to a fair trial of alfalfa. To omit any one is to endanger the whole experiment. They will not ensure success. On many soils alfalfa will not grow successfully. The thing should be tried as an experiment and as one where you can afford to lose. If you succeed, it is easier to increase your acreage than it was to make the start.

Success will pay handsomely, but it will come, like every other success, only with labor and skill and watchfulness. Success is not distributed in any two-dollar packages with nitro-cultures.

DISCUSSION.

Mr. PHELPS. Dr. Jenkins made the statement in his interesting paper that some soils naturally contained the alfalfa microbe, and I think he said that he found that to be the case with the Station grounds at New Haven. I would like to ask if he has found that condition common about the State.

Dr. JENKINS. No. As a rule, I think inoculation is necessary. The soil must have the microbe in it in order to be successful with the crop. It is necessary to inoculate the soil if the organism is not present. I have already spoken of the manner of getting the microbes into the soil.

I might add to what I have already said that you should not be discouraged if the first year you get no crop from your alfalfa that is worth saving, that is, from the first year's seedling. Do not be discouraged if you do not get any alfalfa that you can make hay with. If your plants look heavy and thrifty in the fall, and the field shows signs of your getting a good stand, give a good mulch of stable manure late in the fall and that will probably bring the field through in good condition. The next year, in all probability, the results will be better. Every one of these points is quite essential to the production of a good crop.

Now I recognize that this is a discouraging, lukewarm, and half-hearted sort of a paper, but the intention of the paper has been to give the facts as they appear to us. I think it is better to tell the truth about it as we see it now. There has been so much inordinate praise of alfalfa that it is likely to damage the success of the crop in the State through a misunderstanding of the difficulties in the way of successfully raising it. You remember how it was with ensilage. When ensilage was brought out the shout went up at once that you could increase the amount of digestive food for your cattle by putting the green fodder into your silo and manufacturing a food. After a while it was discovered that the matter was not sufficiently understood. Ensilage did not turn out as was expected, and the consequence was that it got a black eye in this State. Now we are beginning to see things in their true light, and are getting the benefit of that knowledge.

Take the matter of Sumatra tobacco. We went into that quite extensively in some parts of the State in 1900, and after the first crop dealers in New York were apparently so pleased with it that they said it was worth \$1.75 a pound, that they

would give that for it. We sold a lot of it for \$1.75 which, of course, was very encouraging. We cautioned the farmers, however, at that time to go slow until it was fully understood, to try it as an experiment, and not to put in more money than they wanted to throw away, but the promoters came down on the State, companies to raise Sumatra tobacco were formed, subscription agencies were opened in Hartford in special offices, and the farmers in the tobacco raising sections besought to take stock and go into the raising of Sumatra. After a short time it became plain, as many of you know, that the matter was not sufficiently understood, and the result is that the whole business is now as flat as a pancake.

Now it has been somewhat the same with alfalfa. There has been a lot of talk about alfalfa that has been in the nature, as they say on the street, of hot air. It has been boomed by some as something with which we could certainly succeed. We cannot certainly succeed. It depends very much on circumstances, and upon how the crop is handled. It has been tried in the State for twenty-five years. We have been trying it for a considerable time, trying to learn the facts about it applicable in this State. We have been testing growing it with farmers for a couple of years, and we do not feel at all sure about it yet. There are many encouraging things about it, but it is not a thing that we can afford to go into on any considerable scale as yet. It must be tested further. There are two or three alfalfa fields in the State that seem to be very promising, and which look as though they would be worth a great deal to those who have them, but it is not a thing to bank upon as an assured success yet. (Applause.)

Mr. PHELPS. Professor Jenkins has given us a considerable amount of meat in his paper, and we want to see if we cannot digest some of it.

I have interested myself in the work of growing leguminous plants, including alfalfa, and as I have had considerable experience on the subject, I thought possibly it might be of some

interest to the people here, and I want to ask your indulgence for a few minutes.

In the first place, there is need for investigation along this line, from two standpoints; one from the standpoint of soil improvement, and the other from the standpoint of cheaper feeds. I want to speak of the first. For the last six or seven years, it has been my privilege, and a part of my duty, to prepare for use about a carload of chemicals every year, and I have found that the prices of phosphates and potash materials have remained about uniform for the past eight years. There has been very little change in the price from year to year. How is it with regard to nitrogen? When I started in making home mixtures, I could buy nitrate of soda for from thirty-seven to thirty-eight dollars per ton. How is it today? The price has gone up. Last winter, when getting the prices for chemicals, I became quite concerned on the nitrate of soda question, and I began to look around to see if I could find anything for a substitute. I found I could buy nitrate of potash, and get it more cheaply than I could the same amount of nitrogen and of potash in the form of nitrate of soda and muriate of potash. I talked it over with my proprietor, and he said you had better put in five tons of it at seventy-five dollars a ton. This year I thought I would be a little forehanded, and for several reasons it seemed best that we should put in our chemicals in the fall, and I began to get prices. I found nitrate of soda quoted at fifty to fifty-two dollars per ton in New York. I sent to the house where we got our nitrate of potash last year, and it was ninety dollars per ton. That knocked out the nitrate of potash question. I investigated carefully to see where we could buy our chemicals in the bulk best, and found, as the result, that we could save about a dollar a ton, on the average, over New York prices by buying in Baltimore; but at the best, the nitrate of soda cost us over fifty dollars per ton delivered. Now this great advance in the price of nitrogenous fertilizers brings up a very serious question. What

are we going to do with the nitrogen question? What are we going to do for this food element for our plants?

We find the same condition of affairs when we study the question from the standpoint of feeds for our animals. Ten years ago we could buy plenty of cotton seed meal for from twenty to twenty-two dollars per ton. Now we are lucky if we can buy a carload for twenty-eight or twenty-nine dollars per ton, and all nitrogenous feeds have pushed upwards in the same way. We are face to face with a very serious problem, in fact, with a double problem. How can we buy nitrogen for feeding our plants and how can we obtain protein for feeding our animals? It seems to me that along the line of growing legumes on our farms, and the conservation of soil nitrogen by using certain crops as a means of drawing nitrogen from the air lies our best hope of success. I believe, for that very reason, that, in a careful, conservative way, every dairyman should experiment with alfalfa, and make it a success, if possible. I have been experimenting with it more or less for the past six or seven years, but more particularly in the last two years. When I went onto the farm where I am now located I found a very nice field of alfalfa. My predecessor was interested in the question, and he had foreseen the need of alfalfa. How good the crops were before I took charge of the farm I do not know, but I do know this, that we cut three very good crops in the year 1903, and used it for soiling purposes. You will remember what a severe winter we had in 1903 and 1904. During the summer of 1904 we cut three light crops. The clover and other grasses came in, and crowded out the alfalfa, but we used it for soiling purposes, getting, on the whole, a fairly good yield. In the spring of 1905 we started a new field, using about thirty pounds of seed to the acre. I got some pure culture from Washington and attempted to follow their directions for starting it. I should like to relate this because I can see from my experience some difficulties ahead for the average farmer in handling the pure cultures. The directions

were to place the culture in a certain amount of rainwater, or distilled water, adding the nutrient salts, and then to set it in a warm place for a period of twenty-four hours. I did not know what would be considered a warm place. It was, however, the month of May, and the weather was getting warm, so I thought I would set it on the piazza of the house and see what would happen. I left it there for twenty-four hours, but at the end of that period the milky color which the directions said would show did not manifest itself. I said to myself there must be something that is not quite right, I will leave it by the stove. I did so, and the next day the milky condition was very apparent. Now suppose that condition was placed before the average farmer. What would he have done about following directions? I left it in a warm place for twenty-four hours. I knew, however, it was not in condition to use, and I waited for another twenty-four hours. I then soaked the seed in the culture solution, dried it by spreading it on some sheets, and then went ahead and sowed the seed in the usual manner.

I found, in the early part of July, that the nodules were beginning to appear on the roots. I looked over the field, and here and there were plants which had a different appearance from others, and I found, when I dug down carefully, that the nodules were present on the roots. I soon found that I could tell by the appearance of the foliage the plants that would have the nodules, and I could pick out those that would not. Not more than a quarter of the plants showed the presence of nodules, even though I had been reasonably careful in following the prescribed method of seed inoculation. We had a very fine growth which we cut off when about a foot high, about the 15th of July. For the next two weeks the weather was dry, and the weeds came on very rapidly. They choked the alfalfa back and it seemed likely to go into the winter in rather poor condition, so I plowed it up.

In the fall of 1904 we plowed up the old alfalfa field where we got such a good crop in 1903, and a fair crop in 1904. This year, I said, I will see if we cannot get ahead of those weeds. So I re-plowed the field last spring, manured it, and re-plowed it again. During the summer we cultivated and harrowed thoroughly once in about two weeks. The seed was sown about the middle of August, and when the cold weather came on the alfalfa was a thick mat about four to five inches in height. It was looking in good condition as the winter season came on. I think we shall get something in the way of a crop the coming year as the field is now quite free of weeds.

I believe in following out, in a very careful way, the directions that Dr. Jenkins has given, and especially that we must have these inoculating bacteria from some source. If they are not in the soil they must be placed there. I believe if we will follow Dr. Jenkins' advice, and work with the very best methods we can get, there is a fair degree of certainty that we can prove that alfalfa may be raised successfully in Connecticut. We must, however, clear our fields well of weeds during the early summer season, and seed after mid-summer. I should have preferred to have seeded two weeks earlier than I did, or about August 1st, but the working conditions on the farm are sometimes such that one cannot do things just when he wants to do them. I believe fully that alfalfa, and a good many of the other legumes, are crops that we must grow more generally if we are going to produce cheap nitrogen for the feeding of our plants, and if we are going to produce a cheaper form of protein for the feeding of our animals. We certainly should do more than we have been doing in the past toward producing and saving nitrogen on the farm.

Mr. J. B. NOBLE. I would like to ask Dr. Jenkins if we can get a crop of alfalfa in Connecticut whether it is a desirable dairy feed? We know that they do grow large crops of it, and it is fattening for animals, but is it a good dairy feed for the production of milk and butter?

Dr. JENKINS. I have not had any experience. I never got so far that I had a lot of it to feed to cows. I know this, however, that Mr. Stadtmueller, on a big farm at West Hartford, has used it. I believe he is selling milk from thoroughbred Jersey and Guernsey herds, and I know he would not have used it if, in his observation, there was anything about it that was not just right for a good dairy herd. Unquestionably, it is very rich in nitrogenous food, and I should think it would be important as a dairy feed. I never heard the point made anywhere that it was not good for milk and butter products. Of course, Mr. Stadtmueller is raising milk and not butter, and for his milk producing I think he certainly finds it an admirable thing.

Mr. STRAWHECKER: Mr. President, this is an intensely interesting subject to farmers in Connecticut whether we ultimately succeed in raising it here or not. I can hardly agree with the Doctor in the statement made during the last part of his address that his paper was a lukewarm paper. I consider it a very valuable exposition of the alfalfa subject.

It has been my pleasure to have been in a position to observe during the last four or five years considerable in regard to alfalfa growing in central and western New York, and down through southern Ohio. Of course, central New York appeals to us with rather more interest than points further west. They have had splendid success with growing it in New York. I remember riding from Dunkirk into Buffalo along in June, and noticed at one point that the railroad embankment was thoroughly covered with it. In fact, it seemed to be quite a good solid stand.

I knew of a party that started to grow it upon upland ground, and after growing some on lower land he found he could get three good cuttings. The good cuttings were from thirty to thirty-four days apart. There is another point that I would like to ask the Doctor's opinion on, and that is in regard to getting a good stand the first year when it has attained

a height of six inches. It is said if you try to mow it before it gets up to a certain height that it will slip right over the machine. Have you ever had any experience with that?

Alfalfa has a tendency to grow too much top unless it is cut. It needs to be cut at the right time or the stalks become woody. When it is cut at the right time you cannot get any better hay.

As for feeding purposes it is most excellent, and it is highly relished by most all kinds of stock, pigs as well as cattle. They have grown it to some extent in the Housatonic Valley, where I am still interested. Just what kind of land will do the best for it I am not quite sure, but I apprehend it needs a good quality of land. I think it would be almost useless to attempt to start it on some of the old cold river plains over there. I would not want to do that. I think we must prepare perhaps the best land to be inoculated with the proper bacteria, and then the prospect for getting a crop is pretty good.

I am intensely interested in this subject, and would like to hear from any others who have tried it, and especially with reference to the kind of ground it seems to do the best on.

Mr. PHELPS. The gentleman has touched on a very important point, and that is the necessity of taking some good soil. I think that is where a great many of the failures with alfalfa have come about. Farmers have thought that alfalfa, being a legume, would gather its nitrogen from the air and would thrive even if put in rather poor soil. I think that is a great mistake. Alfalfa, especially the first year, gets very little nitrogen from the air, and the soil really wants to be a rich soil. After it gets well established we have got a different condition to deal with, but you want a rich soil the first year.

Mr. STRAWHECKER. I have heard it stated that the bacteria needed for red clover is the same as that for alfalfa. I am not sure whether they are or not. I would like to ask Dr. Jenkins if he has any information about that.

Dr. JENKINS. I do not think that bacteriologists can tell whether they belong to the same species or not, but certainly they are two different strains, if they are not distinct species. They are distinct strains so that a culture that would inoculate an alfalfa field would not with the same efficiency inoculate red clover. I am quite sure they are distinct strains, if not species. Recent observations and tests at one of our agricultural stations, which were repeated by bacteriologists in several other stations, showed that cultures which have been put out by some of the commercial companies with which to inoculate alfalfa fields, showed that they were so full of fungi and other things instead of being a pure culture that if they ever had any of the organisms which would inoculate an alfalfa field to begin with they were run out and destroyed by this fungi and were absolutely worthless for the purposes for which they were sold.

QUESTION. If we sow alfalfa with red clover will it help you out in any way? I do not know whether anyone here is familiar with the work of Mr. Goble at Bristol. He has been trying for a number of years to get some alfalfa on his farm, and has tried both by sowing it in the spring and also in the fall. This year, about the last of June or the first of July he mixed it up with red clover. Will the clover help the alfalfa?

Dr. JENKINS. That I cannot say. It is frequently sown with the clover crop. I never have tried it in that way. As far as my results and knowledge of others have gone they have not seemed to favor the use of any cover crop with it. They have had better results without. In some cases, particularly in the west, I have read of their using clover, but I think it would only help it as a shelter or protection and not in any way help the inoculation of the roots.

Mr. MATTHEWS. Will the alfalfa do any better on land that has the clover bacteria in it? I have the bacteria on my clover. I am using clover as a cover crop, and I was thinking of trying alfalfa, and wondering whether I would be more likely to succeed on the clover land.

Dr. JENKINS. I do not think that clover nodules in themselves will materially assist the success of alfalfa, yet the land on which a crop of red clover is grown will be more apt to raise a successful crop of alfalfa. I should think so. I should say if the soil had sufficient lime, or the right kind of plant food for leguminous plants in it, alfalfa would succeed. In other words, I should expect more success on that kind of land, but not, so far as we know, by any transfer of bacteria from one root to another.

The PRESIDENT. I would like to ask Professor Shaw to say something about this matter.

Prof. SHAW. Mr Chairman and Gentlemen:

As the time is so far gone I will not say very much on this question, although I have thought a little about it and have had some experience in growing alfalfa. The thought came to me when Dr. Jenkins was referring to the fact that sweet clover would grow in dry places in different parts of the State, whether alfalfa would not grow in the same localities. I wonder if anybody has tried it. I will qualify that by saying that it is quite possible for sweet clover to grow in the west in certain localities, and alfalfa grown on that same land and under the same conditions will not grow well. I apprehend it is because the sweet clover has more power to gather nitrogen from the soil than the alfalfa; that it would be necessary, in order to be quite sure of success, to enrich the land thoroughly by applying some fertilizer, and especially, I should say, of farm manure.

Now if the bacteria are not the same, and scientists seem to be agreed on that, for growing sweet clover as for growing alfalfa, it seems to me that all that would be necessary would be simply to enrich the soil. I hope that some one of the farmers in this State will find that out. Dr. Jenkins is undoubtedly in a good position to do it, and it seems to me to be a piece of information that will be of some service to the farmers of this State. I believe that alfalfa is going to be grown right up in the

Saskatchewan River valley in the Canadian Northwest. In fact, it includes alfalfa at the present time. You will pardon me for this personal reference, but when I wrote that chapter on clover and said that the 49th parallel was about the limit of clover as well as alfalfa I found later on I was wrong. I spent sixteen days in riding over the Canadian Northwest, and when I came back home I had to revise that chapter. I said that the northerly limit of growing clover or alfalfa is north of the Saskatchewan River in the Canadian Northwest, — about four hundred miles north of parallel 49. I simply refer to this, farmers, so that you may be encouraged to believe that you will succeed in growing alfalfa. I think you will find the same to be the case in the State of Connecticut. We are growing it in Minnesota very successfully, where the winters usually are much more severe than they are here. We are not growing it all over Minnesota, and we never will because some of our land is not suited to it, and before I sit down I would like to refer to an experience in growing alfalfa that I had myself. It was on a patch of eleven acres, which was, of course, a little large for an experiment. The patch came up fine. It was sown in May, and we cut it off two or three times during quite a wet summer. Some of the cuttings of plants and weeds we allowed to lie as a mulch on the ground, and the plants grew admirably until about the first of September, and then began to wane. When winter fairly set in I said to one of the men to take some of the best rotted manure that he could get in the yard and draw it over the poorest part of the field, and he did so, going over it several times back and forth, and the result was this; that the next summer there was a magnificent stand of alfalfa where the fertilizer was scattered over the poorest part of the field, and on the other part of the field the plants were more or less sickly, so that they were plowed up.

Now I am not prepared to say that farmyard manure has the power of giving to alfalfa the ability to draw nitrogen from the air, that is, to draw it from the air without being inocu-

lated, but I cannot help but think, gentlemen, that there is a pretty close relation between that ability and the amount of fertilizer that is put on the patch.

The **PRESIDENT**. The meeting will stand adjourned until two o'clock this afternoon.

AFTERNOON SESSION.

December 14, 1905.

Music.

Convention called to order at 2 P. M., Vice-President Seeley in the Chair.

The **PRESIDENT**. If the speaker of the afternoon was not in the house, I should like to have the Secretary read some communications just received from two different sources. I think, however, that if the speaker will shut his ears we will read them even though he is here, and I will ask Secretary Brown to read the communications.

Secretary **BROWN**. I think, gentlemen, it is due to you and due to the speaker of the afternoon that a better acquaintance should be established between you, and in order that there may be a better understanding between you and him I will read a letter received this morning from Mr. Herbert Myrick, whom you all know.

"Springfield, Mass., Dec. 13, 1905.

"My dear Mr. Brown:

"Our good friend, Prof. Thomas Shaw, received a warm welcome at Lisbon, N. H.; also here yesterday before the Massachusetts State Grange. I never knew a speaker to be so warmly received by a New England audience. I hope he will be equally beneficial to you. He is absolutely the best informed, from both a practical and scientific standpoint, of any man in his line in this country."

Enclosed with Mr. Myrick's letter was a paper containing what the Master of the Massachusetts State Grange said when introducing Prof. Shaw.

"It gives me pleasure to introduce to this great audience of Massachusetts farmers and their wives the leading expert in America upon the subject of live stock breeding, feeding and management. This gentleman's name is already a household word in New England although this is his first visit here. He has this week addressed the New Hampshire State Board of Agriculture at Lisbon, and tomorrow speaks before the Connecticut State Board of Agriculture. Brought up in Ontario, Director of the Minnesota Experiment Station, and now live stock editor of the *New England Homestead*, he is also identified with the *Homestead's* contest to add millions to the profits of grain growers."

The PRESIDENT. Ladies and Gentlemen, it gives me great pleasure to introduce Professor Shaw, who will speak to us this afternoon upon the subject of "Feeding Farm Animals."

FEEDING FARM ANIMALS.

BY PROF. THOMAS SHAW,

St. Anthony's Park, St. Paul, Minn.

Mr. Chairman, and Ladies and Gentlemen:

The introduction which your Chairman and the Secretary of the State Board have been pleased to give me I must say somewhat takes away my breath. If an introduction of that kind had come after my talk rather than before it I would probably feel a little more self-possessed than I do at present. I do want to say this, however, before taking up the subject that I shall more particularly talk upon; I do want to say that I do hope to be better known in New England in the future than I have been in the past, and I do hope to be able to enroll on the list of my friends a large number of the intelligent farmers of this part of the great American Republic.

I do not know that I have referred to that grain-growers' contest, and had it not been for the reference made in that document read by the Secretary, should probably have passed it over, but I will say simply in passing that it is true that I do have to look after that contest. I believe it is to be the greatest contest that was ever established among the

farmers of any country. In regard to the causes of the contest in growing grain, and increasing the product of the farm, of course, the future can only speak, but I do want to say to you, farmers, that it is not simply an advertising dodge. It is something that is, in my judgment, very greatly for the benefit of farmers everywhere. It is something that is intended to help not only the farmers of New England, but the farmers all over the United States.

I have been announced to talk to you on the question of feeding live stock, — a great, wide question, like the question that I attempted to speak upon yesterday. I can see, brethren, as you cannot, perhaps, some difficulties with the discussion of this question before an audience of Connecticut farmers. I put the question to several, — are any live stock fattened in Connecticut? And generally the answer came in the negative. I did hear about one or two that attempted to fatten live stock in a somewhat extensive way, but I have yet to meet the first man who is fattening live stock upon his farm in the sense in which live stock is fattened upon the farms of the western country. I know, of course, that my subject does not confine me to the question of fattening live stock, because it is a question which involves not only the fattening of live stock but the feeding of dairy animals and the feeding of all kinds of farm stock. I put this question to the same men. I said, "Do the farmers in Connecticut grow their own meat for their tables?" but, farmers, they told me "No." I asked, "Do the farmers grow their own pork for their own tables?" and, farmers, they told me "No." I wonder why Connecticut farmers do not grow their own beef, and do not grow their own pork, for I do not need to tell you, farmers, that every dollar kept upon the farm in that way is a dollar saved. I am not here on this platform to tell you that you cannot bring in cattle from the west and fatten them and sell them in the market here and make them pay you. I am not here to tell you that. I am here, however, to tell you that I do not see why you should do that; that it is my profound judgment that you can grow your own beef, that you can grow your own pork, and you can do it just as well, and, in fact, you can grow better beef and better pork than you can buy. You can do it cheaper than you can do it by getting it from elsewhere to be-

gin with and putting the stock through the fattening process here.

The successful feeding of farm animals is never the result of accident. It is the outcome of giving food and care more or less in conformity with the leading principles that govern such work. The measure of the success will be the measure of the fidelity with which these principles have been observed. True, the individual who thus succeeds may not be able to formulate those principles, but he unconsciously follows them all the same, or success would not crown his efforts. In the absence of formulated principles the individual must learn from the experience of some one else; in their presence he has a safe guide, in the absence of experience, although experience is necessary to enable him to apply them in the most successful manner.

The following are chief among the leading principles that govern the successful rearing and feeding of farm animals:—

1. They must possess quality before they can be fed and reared with marked success.

2. More food is required to make a given gain as the birth period is receded from.

3. When periods of stagnation occur before maturity, the food of maintenance, fed during such periods, brings little or no return.

4. When development is seriously arrested at any period before its completion, the feeding quality of the animal is affected adversely.

5. When development is unduly forced by stimulating foods while the animal is young, its feeding qualities are injured.

6. In the fattening process, when animals are so ripened that they cease to make good gains, further feeding can only be done at a loss.

7. In selecting a ration for feeding, a due regard must be had to the chemical constituents of the food or foods which compose it.

8. In nearly all instances a mixed diet is superior to one composed of any one food.

9. In fattening animals the profit or loss resulting is largely influenced by the cost of the animals up to the time when the fattening begins.

10. Pregnant animals should be maintained in a good condition of flesh.

11. When animals are exposed to temperatures below what is normal, additional food proportioned to the degree of the exposure will be necessary to restore animal heat.

12. Discomfort from any source arrests development and consequently produces loss in proportion to the degree and continuity of the same.

Quality when applied to farm animals is comprehensive or otherwise as the term is defined. More commonly it has reference to handling the skin and flesh, especially of cattle. When thus applied it has reference mainly to the sensation conveyed to the mind through the sense of touch. Its presence is usually sought by touching certain portions of the body with the finger tips to ascertain the depth of the covering, and by grasping the skin over the ribs within the hand to ascertain its looseness and flexibility. A good depth of elastic flesh relatively over the portions that are more difficult to cover, as the loin and shoulder blade, and loose, pliant skin are indicative of good digestive qualities as they are the outcome of these.

As used here, however, quality is used in a wider sense, that is to say, in the sense of capacity for well doing as indicated by the breeding and form in addition to the handling. The breeding of animals has, of course, an important influence on their feeding qualities. As a rule, well chosen, pure bred animals of the beef breeds will make greater gains and more rapid gains from a given amount of food than will common stock of mixed and inferior breeding, or than animals of the various dairy breeds. This statement has been denied, and some of the experiments conducted by the experiment stations would seem to favor such denial. Other experiments tend to sustain the opposite view. Of the correctness of the stand taken, however, I have not the shadow of a doubt. Good digestive and assimilative qualities are as much a matter of transmission as qualities or properties that relate to form.

The possession of correct form is, of course, immensely important. The precise nature of such form will be largely dependent on the precise object for which the animals are reared. In meat-making animals it usually means much relative width and depth, and fore and hind quarters well balanced as to weight. In milk giving animals it means much capacity

of barrel and various other accompaniments which cannot be mentioned here.

The difference in capacity of animals similar in age, breeding, and form, to digest and assimilate food, is very great. It varies in some instances between fifty and one hundred per cent. One steer being fattened will sometimes gain but little more than one pound a day, whereas another steer will gain two pounds per day on practically the same food. But the difference in returns in meat-making animals as the result of form is no less great. One animal possessed of correct form will sell for five cents per pound alive, when another fed for as long a period will only sell for three cents, the difference being based entirely, or almost entirely, on form.

As a rule, the amount of food required to make a pound of gain in meat-making animals increases as the birth period is receded from.

It is easily possible to make an animal of beef inheritance gain two pounds daily during the first year, not including birth weight, even though reared essentially on skim-milk and adjuncts during the milk period. The same animal is not likely to increase in weight the second year more rapidly than one and one-half pounds per day, or the third year more rapidly than one and one-quarter pounds per day, notwithstanding that more food was consumed the second year than the first, and the third year than the second. The explanation is found in greater activity of the digestive organs near the birth period and to the increase in the cost of the food of maintenance as the birth period is receded from. Young swine furnish an exception to the rule regarding increase in weight, but not in regard to increase in the food required to make weight. Young swine while nursing cannot be made to gain so rapidly as at a later period.

The economy of pushing our meat-making animals rapidly from birth until ready for the block will be readily apparent. The importance of so doing increases with relative increase in the cost of food. It may be different where, at certain seasons of the year, cheap and coarse foods are abundant on the farm, and it is desirable to utilize them to the utmost, or where pastures are partly or wholly free, as on the range. It may be that a steer grown on the range will bring the greatest profit sold at four years. It may also be that a steer grown on farms

in the Mississippi basin, where, oftentimes, much fodder is wasted, will bring greatest profits at three years, but in the eastern and New England States, greater profits will certainly come from selling steers finished at an age not exceeding two years, where food is relatively dear.

The truth must be self-evident, that if at any time before development is complete, growth ceases in whole or in part, the cost of the food of maintenance is proportionately increased. If cessation in growth is complete, there is no return for the food of maintenance during its continuance, unless it be under conditions where animals are thus carried on until they can be maintained on cheaper foods. For instance, it may pay a ranchman to carry an animal through the winter without gain in order to bring it to that season when it will graze on pastures that cost but little or are entirely free. But it will not pay the eastern farmer thus to carry a young animal through the winter, since pastures on eastern farms are valuable as well as coarse foods.

The farmer who puts a young animal in winter quarters at the advent of winter, and who turns the same out to graze, say, five months hence, without any advance in weight, has virtually lost the food fed during those five months. The only return he has is a poor grade of fertilizer, the value of which will be largely offset by the labor expended in caring for the animal and the cost of providing suitable shelter. In growing meat-making animals, therefore, on eastern farms, the wisdom of keeping the animals growing all the while and with prudent haste, and of selling them at a relatively early age will be abundantly apparent.

Should development be arrested in whole or in part at any time before it is completed, the capacity for future development is weakened in proportion to the degree to which development was hindered.

When the hindrance to development is slight and covers but a short period, the injury resulting may be so slight as to be imperceptible. Notwithstanding, time is lost in completing development and there is also a proportionate loss in the food of maintenance. If the arrested development has been prolonged and severe, in addition to a proportionate delay in completed development and a proportionate loss in the food of maintenance, there will also be a proportionate loss in the

capacity for future development. Feed the animal ever so well subsequently, and it will never wholly regain what has been lost. In other words, the same profit can never again be made from growing the animal that would otherwise have been possible. If the arrested development has been exceedingly severe, then the loss of capacity to develop may be so great as to preclude the possibility of making any profit from rearing the animal under any conditions howsoever favorable. It should also be remembered that the loss of capacity for future development is greatest when arrested development occurs near the birth period, and gradually grows less as it is receded from. The importance, therefore, of keeping animals pushing on with prudential haste from the day of birth until development is complete, or until they are ready for the block, cannot be easily over-estimated.

Arrested development may arise, of course, from various sources. It may come from insufficient or unsuitable food, or food both insufficient and unsuitable, also from food excessive in supply and nutrition, or from undue exposure, or from several of these, and it may be other causes combined. It would be too much to claim that the source of arrested development did not influence the loss of capacity referred to, but it would not be claiming too much to say, that whatsoever the source, the loss in capacity to develop will be serious whenever prolonged periods of stagnation occur in the early growth of the animal. The unsatisfactory development subsequently of the ill-cared-for whey-fed calves furnishes an illustration.

When food is exactly adapted to the needs of a young and growing animal, it would not be easily possible to injure the animal by over-feeding, but it would, of course, be easily possible to waste food through careless feeding. Exact adaptation has reference to foods in due balance both with regard to chemical constituents and proper adjustment between the concentrated food fed and the roughage. With some foods adaptation is so perfect that animals feeding upon them will not injure themselves and will at the same time make satisfactory development in the line sought. This is true of rich pastures grazed in summer, and of clover and alfalfa hay fed in winter. Other foods fed at will may be seriously harmful, in fact, positively dangerous, while at the same time they are helpful when fed with due regulation. For instance, one feed of rye meal

consumed at will may destroy a young animal, while a suitable amount fed from day to day with other food adjuncts would be decidedly helpful.

Injury from excessive feeding of meal to young animals most commonly occurs when they are less than one year old. During the milk period, young calves will seldom, if indeed ever, injure themselves by feeding ever so freely on a meal ration composed of ground oats and wheat bran fed in equal parts by weight, nor are they likely to injure themselves subsequently on such food with suitable fodder adjuncts. The reference here is to animals grown for meat. But a time comes when so much of the meal would be consumed that it is unprofitable to feed it longer at will. But suppose instead of the meals mentioned, corn was used, or rye, or a mixture of these, a time would come when development would be checked, if not positively arrested. The too concentrated character of the food in conjunction with the excessive amount fed has overtaxed the digestive and assimilative organs to the extent of weakening them it may be permanently.

When the animals are being grown for milk production the properties concerned in future milk production may be weakened by such feeding before the point has been reached when the digestive organs become impaired. The injury may come from the influence which the food has exercised on assimilation. It has strengthened the digestive habit of utilizing the food in making fat and the influence in this direction is felt even after the female has begun to produce milk. It is possible, however, if not indeed probable, that this thought has been carried too far in the rearing of dairy heifers.

When animals are so forced during the finishing period by feeding so much strong meal that they get off their feed, that is, lose appetite in whole or in part, the danger point has been reached. The digestion has been more or less impaired. Cessation in feeding the meal or the grain that has caused the trouble is the remedy. In many instances, however, subsequent gains will be less than they would have been had the digestion not been thus impaired.

It is also true that dairy cows under high pressure feeding may have the milk giving function weakened in the absence of any symptom of indigestion, results from sheer overwork. The machinery of digestion has been driven at a speed so high

and so continuous that the wear has been excessive, although there has been no breaking down in any part thereof. The limit of the period of high usefulness in a dairy cow may thus be easily and materially shortened.

Animals that are being fed for the block are ripe when, under normal conditions of feeding they cease to make material gains. If kept longer, the larger portion of the food fed is given at a loss. The loss may soon become serious, for, under such conditions, they may continue to consume large quantities of food. Such ripeness is indicated by a firmness of the flesh under gentle pressure or by marked falling off in the gains under suitable conditions of feeding. In an experiment conducted under my personal supervision, pork during the fattening period was made up to a certain point at a cost of approximately four cents per pound, whereas during subsequent weeks the cost was approximately ten dollars per hundred pounds, the food being fed the same in kind. The importance of disposing of animals promptly when finished is thus apparent.

The mistake, however, is far more frequently made of selling animals unfinished. Probably ninety per cent. of all the cattle sold reach the block under rather than over-finished. This more than anything else probably is accountable for the too common belief that there is no money in fattening cattle. Sometimes cattle are sold half finished because the price of food has become unduly high. At other times, because suitable food supplies cannot be obtained, but more frequently, perhaps, because many do not properly understand what good finish in cattle means.

When foods are being fed a due regard must be had to their chemical constituents, which means that a proper relation must obtain between the amount of protein and carbo-hydrates fed under normal conditions of feeding to insure the most satisfactory results. This relation will vary with the animals fed and the objects sought from feeding them. These varieties cannot be discussed, they are so many. There must also be a certain relation between the amount of concentrates and roughage to bring highest profits. But since this relation is a shifting quantity and is to some extent affected by food values, it also will not be discussed further.

I call attention to the important fact here, that the real value of a food factor may be more or less in practical feeding

than chemistry would assign to it on the basis of food constituents. Two factors at least must be considered in judging of the value of a food in addition to the chemical constituents which it contains. The first is palatability, and the second is the influence exerted on the digestion. Thus, rye straw, because of its low palatability, has a lower food value than chemistry would assign to it. Animals will not eat it freely unless impelled to do so by hunger. On the other hand, field roots have a higher food value because they favorably influence the digestion.

The further fact is also significant, that in some instances, foods may be fed at a greater profit when fed out of balance rather than in balance. This is possible when one food is so much cheaper than another opposite in character, that it may, as it were, be fed in excess. I have fattened lambs at a greater profit on a ration not in balance than on one in balance, because of the relative cheapness of corn, a leading factor in the former. In alfalfa areas, it also sometimes pays better to feed protein in some excess than incur the cost of securing other foods to balance the ration.

In feeding animals for a prolonged period, a mixed diet is superior to a ration composed of only one or two food factors. This may, to some extent, be owing to some chemical action which the foods exercise one upon the other in the process of digestion. It is probable, however, that it is due more to the influence exercised by the combined foods on the appetite and to the more even balance that is thus likely to be secured in the mixed diet. Animals, like individuals in the human family, tire of one kind of food when fed continuously upon it. To this there may be some few exceptions. They tire more quickly of some food factors than others. Swine, for instance, will consume corn for a longer period with a relish than barley or rye, and horses will consume oats with avidity for a longer period than any other kind of grain.

These influences are more noticeable when the feeding is forced, as when animals are ripening for the block. The appetite under such feeding slackens, hence any judicious change of diet that will lead them to consume more food will usually be found helpful.

Among the many influences which affect the profits that result from feeding, but three will be discussed here, viz:—

the influence of food values, of cost before the fattening period, and of the price received for the animals when sold.

The influence of food values is so evident that it is scarcely necessary to discuss it. Other things being equal, the difference in returns from feeding corn at twenty cents per bushel and the same at forty cents will be at once apparent.

Some seasons the price of food varies much. One kind of grain may be dear and another kind cheap. All kinds of grain may be relatively dear while fodders may be cheap. Under such conditions, the aim, of course, should be to feed the cheaper foods as far as may be judicious in the one instance, and to utilize fodders as far as may be practicable in the other. Sometimes, however, it may be advantageous to feed more or less of the dear food, because of the advantage which results from feeding foods in balance.

Where the conditions are normal it follows that, as a rule, foods may be more cheaply grown by the farmer than purchased, but it may, notwithstanding, be necessary to purchase more or less of one or more food factors not readily procurable from home sources in sufficient quantities. The grower may thus find it profitable to purchase wheat middlings freely, notwithstanding that he may be a large grower of corn. It is also generally true that fodders are relatively cheaper than grains, hence the larger the amount of these that may be judiciously fed, the larger will be the profits. In this fact is found the justification for the free use of corn ensilage in feeding live stock and in chaffing and mixing dry fodders with meal, in order to increase the consumption of the former.

As a rule, a pound of increase made during the finishing period costs more than the food used in making it. To this there are some exceptions, as when meat brings a good price while the foods used in making it are cheap. If, therefore, profit is to be made on home raised animals fattened on the farm, it must come from the two following sources, viz: the growing of the animals on cheap foods up to the time when the fattening begins, and the increase in value on every pound of live weight possessed by the animal at that time resulting from the fattening process. The profit of the feeder who buys the animals which he feeds can only come, of course, from the last named source.

Suppose, for instance, that a feeder purchases a steer at four cents a pound live weight, feeds him for six months and sells him for five cents a pound. Suppose the weight when purchased was 1,200 pounds, and when sold 1,500 pounds, the gain being three hundred pounds. Now suppose the three hundred pounds cost fifteen dollars to make it, then no profit has been made on the increase in weight. The profit comes from the advance of one cent per pound in the value of each of the 1,200 pounds of weight possessed by the animal when the feeding began, that is to say, it would be twelve dollars, leaving the value of the manure to offset the labor and interest on the investment.

The close relation, therefore, between buying and selling prices in animals that have been fattened is very apparent. The difference between the buying and selling price, as a rule, should not be less than one cent per pound, if any considerable profit is to come to the feeder. Before substantial profits can be assured this difference should be from one and one-quarter to one and one-half cents per pound.

At first thought it may be imagined that, since profit in feeding comes from the increase in value in the weight possessed by the animal at the time of purchase, the more the animal weighs at that time, the greater will be the profit resulting from fattening. In many instances that does not follow, since young animals considerably below maturity make greatest increase for the food fed to them.

The fallacy so extensively believed that pregnant animals should be kept in moderately low flesh has done much harm. It is, of course, quite possible to keep a pregnant dam in a condition of flesh too high for the well-being of the progeny, but the instances in which this occurs are few indeed compared with those in which the opposite is true.

The pregnant animal while in this condition must maintain herself and also nourish the foetus which she carries. The double duty thus present calls for liberal feeding. Where this is not forthcoming, the foetus is sustained in part at least at the expense of a lowered condition of flesh in the animal. This, of course, reduces the ability of the dam to properly nourish the offspring after birth.

After the young animal has been born, the drain upon the dam for its sustenance is usually heavy. To meet this need,

the tax upon the system of the dam usually lowers her flesh though liberally fed. It follows, therefore, that a dam in good condition when her offspring is born can nourish it better than one in low condition. The former has stored up flesh previously which is now drawn upon to feed the offspring.

Animals that are being fattened must be protected from excessive cold or the cost of food in proportion to the gains made will be materially increased. It is probable, nevertheless, that more loss results from keeping animals too warm and closely confined while being fattened than from exposing them unduly to cold. Recent experiments have shown that animals fattened in sheds with liberty to move about in the same, and also in yards adjacent, have brought higher profit than those tied in the stall. The former consumed more food, but they also made greater gains.

The degree of the exposure or of the protection that should be given varies with the class of the animal. Sheep, for instance, will bear more cold than cattle, and cattle than swine, but it is imperative that all animals that are being fattened shall be protected from storms. Food is expensive heating material.

The feeder who attains to marked success in this line of work must study carefully the needs of the animals which he feeds. If the conditions prove too warm through change of weather, more ventilation should be promptly given. If they prove too cold, additional attention should be promptly given. If an animal gets off food, immediate attention must be given to its needs. The more completely comfortable that animals can be kept, the better they will flourish, and it will be the constant endeavor of the faithful stockman to make them comfortable. While engaged in such work, he can never come down from the watch-tower of vigilance, and his reward will be proportioned to the fidelity and intelligence which he has shown in his work.

Now I think I should not talk longer on this question, but I will be glad, if any of you have questions, to answer them if I can.

DISCUSSION.

Mr. DIMOCK. I would like to ask if you recommend feeds that the cattle do not relish?

Prof. SHAW. The question is as to how much stress should be laid on palatability, provided the animals take it. I would be satisfied if the animals would take it. I would not care particularly how much of a relish they had for it if they would only take it.

QUESTION. Can we gain anything by feeding roots, such as carrots and turnips, under the same circumstances as silage?

Prof. SHAW. I would say in answer to that, that the ensilage is cheaper. If you look at it simply from the standpoint of making milk it is better because corn can be grown more cheaply than roots, but corn will not do everything that roots will do. As I said before, if a man has a silo, and he feeds ensilage to his cows, he has got to feed a large quantity of corn if he is going to get the results. Now then if along with the ensilage he can feed half a bushel of roots a day he need not give as much silage. If he has the roots it is economical from that point of view. Merely feeding two or three pounds a day I do not imagine will be enough.

A MEMBER. About five or six years ago I visited some relatives in one of the best dairy districts of the country. They were making first-class butter, and their butter brought the very best prices. They were using nothing but rutabaga turnips and hay. As soon as their milking was done they fed the cows a large quantity of rutabaga turnips, and they got a great deal of butter from their herd, and were able to get the highest prices in the market. What do you think of that practice?

Prof. SHAW. Well, I can imagine that rutabagas might be fed to such an extent that the customers might complain, but I am satisfied that if fed as you say, that is, fed after milking, that quite a considerable quantity can be fed a day without tainting the milk.

A MEMBER. I would like to ask the speaker if he would advise us to do away with our dairy cows and grow beef?

Prof. SHAW. I did not say that. Unhesitatingly, I should

say, raise some beef, raise enough to kill for the family meat. I maintain that any dairyman can do that.

I understand that many of you are sending your milk away to the cities, and therefore you have not much left, but I do not suppose there is any dairyman but what has enough left for one animal. Of course, it depends on how much you get for your milk, and it depends also on the way you are shipping your milk away, whether you are making butter, whether you are separating your milk at home, etc. I would say that if you are separating your milk at home, you had better raise every one of your dairy steers, the Jerseys and Guernseys probably up to the age of eight to twelve months, and the Holsteins probably to the age of eighteen months. It would probably not be wise to keep them longer than the time mentioned. Of course, you will have to raise them principally on skim milk. They would not get whole milk more than one or two weeks at the best. If you are separating your milk, it seems to me, it can be utilized in this way so as to bring in a nice little sum of money if the stock is properly grown. Of course, after a certain time the farmer can feed bran, oats, and especially those roots that I have been talking about. They are all good.

Mr. J. HOYT. I understand that the western people when they bring the steers in in the fall dehorn them so that they can be shipped closer together. Do you think it is a good practice?

Prof. SHAW. Of course they must be dehorned. It is a necessity, because they would hurt each other, and probably, in some instances, it would amount to a loss of a steer or so. They are apt to get hooked. It is not a matter of choice which a man who is fattening cattle has. He must do it. I am strongly in favor, especially in the west, of fattening cattle in an open shed rather than in a stable. In that respect I have completely changed my mind, and especially so since I have had experience with keeping steers in the west.

Mr. H. O. AVERILL. Mr. Chairman, I was somewhat surprised to hear the speaker recommend that cows be kept out of doors more, and that they be kept in cold barns. Now if I were to keep animals for the purpose of seeing to how good an old age I could keep them, that principle might be the correct one from my point of view, but if I am going to keep dairy cows for the purpose of trying to get the most profit out of those cows every year, it would be my theory that we should keep them in comfortable, warm barns. It would be my theory still further that they should be kept in the barns especially in unpleasant or inclement weather. Perhaps it would be well to let them out to get the fresh air for a short period of time, but I believe that cows which are kept in warm barns, if they are let out in wintry or inclement weather that the contrast from going from the warm barn out into the cold air is not beneficial, and especially so if they are allowed to remain, even if it is not a stormy day, for any great length of time. The change will certainly be a shock to the vital energies of those animals, to their systems, such as will make them susceptible to tuberculosis, if tuberculosis exists in that herd. I think it will be a shock to their systems such as would injure their production of milk. I should like to ask the speaker if he would advise a dairyman, who was striving to secure the greatest profit each year from his herd, to leave his cows out in cold weather in the winter time?

Prof. SHAW. I would say in answer to that question, unhesitatingly, no. I am in entire agreement with every word that you have said. I probably did not make myself as clear as I should have done in speaking on that question. The point I wanted to emphasize was this: that, in my judgment, a great many dairymen have injured their cows by keeping them in stables too warm, in the first place, and too illy ventilated in the second place. I do not know whether you Connecticut dairymen have made that mistake. I do know that many Minnesota dairymen have made it, and with but one result, that the

State Veterinary Inspector has been called in and the animals have been treated for tuberculosis, and whole herds, in some instances, have been slaughtered. It is that that I am seeking to guard against. I do not know whether you have any tuberculosis in Connecticut. I hope you have not, but if you have I think you may take it for granted that it has arisen from one of two sources. The first source is too close breeding of the animals, in and in breeding, and the second source, and the far more fruitful source, is keeping the cows in stables too warm, and more particularly where they are illy ventilated. I think you will find that tuberculosis has arisen from that cause a great deal oftener than from exposure, or from giving them that shock to the system to which you have referred. Of course, it is bound to occur if you turn them out in the cold, but I think the danger is the greatest from the source I have indicated.

Secretary BROWN. How many times daily would you feed a herd of dairy cows, twice or three times? There is a difference in practice on that point.

Prof. SHAW. I would feed but twice a day. If the animals are given enough twice a day at regular times they eat that food up and then they stand in perfect rest and manufacture that food into condition to be assimilated, that is, by chewing it over in the cud. I think the best results will be gotten in that way.

A MEMBER. Do you advocate giving warm water to dairy cattle or cold water?

Prof. SHAW. I question whether it will pay to give hot water to a herd of dairy cattle, especially if they can get access to good pure water as it comes from a well, an ordinary well or from a good spring. If they have to choose between drinking from a vat in the yard where the ice has been broken away, and the water is icy cold, then I would say give the warm water unquestionably, but I do not think the cattle need it heated if they can get it from any such source as I have indicated.

Mr. J. HOYT. My experience has been that the cattle like cold water better than they do hot.

The PRESIDENT. There is a great variety of opinion on this subject, the same as with other points in the life of the dairy cow. I have found it so. Now there are points that have not been brought out this afternoon, and I would like to have them brought out.

Mr. MITCHELL. During the course of the speaker's address this afternoon he spoke of the effect of temperature. It may be of interest to the farmers present if I relate the circumstances of a case in this matter of temperature. There was a large herd of Holsteins kept in New York state, and in order to settle this question of the best temperature they tried some experiments. They began at about forty degrees and increased the temperature to about sixty, taking pains to see to it that the cattle breathed pure air all the time. It was found that they increased the amount of milk. They attempted to keep the temperature at about fifty, as they found that at that point they secured gratifying results.

I also want to report that at the Vermont Station they carried out some experiments to ascertain whether there was any difference between the productive capacity of cows kept in the barn and those let out in severe weather, and put back. The result was in favor of letting the cows out for a little time in the morning.

Prof. SHAW. I am obliged, Mr. Chairman, for the information just volunteered. I would like to ask, however, if the gentleman knows over how long a period those experiments extended. If the cows were kept at that temperature that you referred to I think it would take a number of years to determine the full results. No doubt the present results favor what you say, but what would be your opinion?

Mr. MITCHELL. This was four or five years. I was in the barn about four years ago. I presume the temperature was not above fifty-two or fifty-three. I know the owner of that

herd has been very successful in that way. He is not only particular to keep the temperature at about a certain point, but he is also particular to have good ventilation and good air.

Prof. SHAW. I can imagine that a stable for dairy cows ought to be kept a little warmer than a stable for animals that are being fattened, and especially when they are being fed corn, owing to the peculiar nature of that food. It is very heating. If animals are being fattened it would be too warm.

QUESTION. How much would you feed to fatten an animal per hundred pounds live weight?

Prof. SHAW. If I got that question correctly, it is this: how much should be fed to an animal that is being fattened per hundred pounds live weight? I think I can tell some things of a little interest in regard to that. If you were to ask that question of a man living in the heart of Illinois, or in southern Minnesota, he would tell you that the steer should have about thirty pounds per day of corn. I tried some experiments on that once. The steers that were fed in that experiment averaged about nine hundred pounds when the experiment commenced. They were fed about six months, and they averaged about twelve hundred pounds when the experiment closed. I fed three of those steers at the beginning with six pounds of meal a day. They had about twenty pounds of ensilage right along together with the six pounds of meal. The balance of their ration consisted of mixed hay. A pound of each was added per month during the six months. We began another lot at eight pounds per day and added a pound every month. Another lot began at ten pounds a day, and a pound was added to that ration every month. When the experiment was completed the steers that I began to feed six pounds a day had made practically as much gain as the steers that I began to feed ten pounds a day. There was not much difference in the amount of hay consumed by the three lots. Now the philosophy of the thing is evidently this: if you give a steer all he

will take he will take more than he can utilize. I tell you, farmers, the whole science of feeding in the west has got to be revolutionized inside of the next few years. The feeders cannot stand it. They cannot make beef at present prices by feeding the amount of corn per day that they are giving. Some are feeding half a bushel.

Mr. HOYT. You think they are wasting a good deal of corn?

Prof. SHAW. I know they are. I have told them so.

A MEMBER. I would like to inquire as to the best way of feeding a grain ration; whether it should be fed dry or moist.

Prof. SHAW. I do not think that it makes any practical difference, provided you can get the animals to consume enough rough food. As you can see, some kinds of food are not as palatable as you would like, but you want to get the animal to take that rough food, and naturally sprinkle meal over it, and the animal will consume more of such rough food or cheap food. I tell you, farmers, it is worthy of the most profound study to get our animals to take all the rough food that we can get them to take, and take as little grain or meal as they will do well on. That is where the profit lies. Now if I was feeding grain along with ensilage, I would put the ensilage in the manger and spread a little meal over it, letting the cattle do the mixing. If I was feeding coarse hay or straw, of which animals will consume a certain amount, I think I would mix the meal with the hay and straw.

I would like to ask, Mr. Chairman, if the dairymen of Connecticut who are making butter, grow many swine? How is it, farmers?

Secretary BROWN. I can answer for my section, and I believe in the sections where we have creameries, the skim milk is taken and fed either to calves or pigs and quite a good deal of pork is made.

Prof. SHAW. I am glad to hear that. That, of course, is as it ought to be. I put the question with this in my mind.

As doubtless many of you farmers know, the roots I have been talking about make splendid food for brood sows, especially when fed with a few ears of corn or a little barley or something of that kind. It is an exceedingly cheap food.

Secretary BROWN. There is one point in regard to feeding animals on a Connecticut farm that I think should be emphasized, and that is this: depend upon your farm for just as large a per cent. of the food of your animals as possible. Do not go to the west or to the grain dealer for a single dollar's worth of feed for your cattle that you can raise on your farm. The present year my ensilage corn was not quite as thick as I intended to have it, and the consequence was I grew a great deal heavier crop of ears than I expected to. I had a couple of acres of corn that I could not get into my silo. That corn was heavily eared. We cut it, partially cured it, and set it up in big shocks. Last Saturday (December 9th) I commenced to feed that corn. We ran it through the cutter, ears and all, and into the shed, and I am feeding that to my milch cows, without any other grain. They do not get a particle of other grain except what is in that corn. I am not going to pay out a dollar to Minnesota or Illinois for grain to put into my cattle while this lasts.

QUESTION. How thick would you advise us to plant corn for a silo? Thick enough to grow a few ears?

Prof. SHAW. I would prefer in planting corn for the silo to have quite a considerable amount of grain. I do not think it is at all hurtful to get the greatest possible maximum of grain because I do not think in that case there would be enough for the stock to waste. A fodder crop, however, may be almost entirely without ears, but in the other case a crop which would produce the greatest maximum amount of grain.

The PRESIDENT. At what stage would you cut it?

Prof. SHAW. I would cut it at the green stage. I do not think that that can be improved upon. If the corn was planted very late so that I was not likely to get it into the silo before

frost, I think it should be allowed to wilt, probably for a day, before putting it in the silo, and that would prevent excessive acidity which would otherwise characterize that kind of ensilage.

Secretary BROWN. Mr. President, I beg pardon for interrupting again, but I desire to give a word of experience. One fact, you know, is worth a hundred theories. I had the misfortune a few years ago to procure some very poor seed corn for my silo. Of the first planting I do not believe there was more than one grain in a thousand came up, and the second planting gave me such poor returns that I found I had not silage corn enough to more than half fill my silo. At that time I had a large crop of field corn, our common flint corn, and in order to have the ensilage corn and field corn go into the same silo together, I allowed the field corn to thoroughly ripen, and the ensilage corn was then pretty green. I picked the best ears from three or four acres of the field corn, and it was white unto the harvest when I picked them. I filled my silo half full, I should say, with that dry corn fodder from which the best ears had been plucked. On top of that I put the ensilage corn, of which there was enough to fill the silo, and when we opened it in the winter, and got down to that dry corn fodder, I found the best ensilage there was in the pit. The very best there was in the pit was that dry corn fodder which was at the bottom of the silo.

QUESTION. Did you wet it when you put it in?

Secretary BROWN. Not at all. It appeared perfectly dry to look at it from the field. It was a pretty good growth of flint corn but the stalks were green. The leaves and the husks were quite dry.

QUESTION. I would like to ask Mr. Shaw what the difference is between those two kinds of stalks that we find in corn.

Prof. SHAW. Mr. Chairman, I could not give the chemical constituents of the difference in the two, but I lean strongly to this opinion, that as the stalk corn grows up it gets dry in

one case and in the other case, where it produces an ear, it simply gets ripe. If you have as many stalks as can be grown without ears in the one case, and you grow just what stalks you can to make a reasonable crop in the other case, I am inclined to think that you will have as much nutriment in the one case as in the other, only you will have more bother.

I was particularly pleased with the remarks made by your Secretary, Mr. Brown, when he stated that it should be the aim of every farmer to raise all the food that he can possibly raise on his own farm, and not send to Minnesota or to the west to buy grain. I do not think that that can be too strongly emphasized.

The PRESIDENT. I wonder if any man here has tried to any great extent the sowing of oats, and then cutting them just as they were turning for fodders, straw and all.

A MEMBER. I have tried that for two years and I like it very much.

The PRESIDENT. Do you find any better way of using your oats?

A MEMBER. No sir; I think it is one of the best fodders we have.

Secretary BROWN. We have not had an oat thrashed in twenty-five years. Every spear of oats that grows on my farm is cut in the milk and cured and fed to the cattle in that condition.

A MEMBER. I think they are worth a great deal more without thrashing. I have tried it both ways, and I would rather have my oats in that shape than hay.

Prof. SHAW. I would like to ask if any of you farmers have grown cow peas along with your oats and fed them in the straw?

A MEMBER. It seems to me to be a little too cold in this climate to do that. I think it requires a little warmer climate. I have tried it once or twice, but not very successfully.

Prof. SHAW. I cannot understand how that can be. I am told that they can do it in Massachusetts and in northern New York. They also do it in New Hampshire.

The PRESIDENT. I do not think that they can do it here.

A MEMBER. I think there has been quite a change in the last few years in the method of feeding oats. The practice of thrashing seems to have completely died out so that it is a rare thing to even see a thrashing machine. I think the modern practice has been very successful. People would not have been doing this for twenty or twenty-five years unless the majority of the farmers thought it was the more practical method. We have a good market here for our hay. We can get for a good part of the time from eighteen to twenty dollars a ton, and if we can feed these oats it is just as well to do it and sell your hay at twenty dollars or thereabouts.

Prof. SHAW. I would like to ask if the farmers of Connecticut grow sorghum to any extent for feeding cows? Has anybody present done that?

A MEMBER. I have tried that. I also know that some other people have tried it here, and I have heard some people speak of it very highly. I tried it in an experimental way for two years, but I think there is something about the New England climatic conditions which militate against its successful cultivation here. It does not seem to do well.

Prof. SHAW. In the west we can get more bulk with it than in corn.

A MEMBER. My experience with it extended over two years, and that was some time ago. Perhaps the cultivation of it in a New England climate is better understood now, but I have not tried it lately.

Prof. SHAW. Did you grow it thickly?

A MEMBER. Yes. I put it into drills and also sowed it broadcast. I tried it both ways.

Prof. SHAW. It is a particularly valuable crop in the west because of its palatability.

The PRESIDENT. It is almost time for us to close this discussion, but before we do so I want to say a word.

Now there is just one thing about this whole matter that we have been discussing and that is, comfort. Make your cattle, your stock, comfortable and they will thrive. When you talk about this matter of your cows being turned out into the cold I think we should be guided largely by what makes them comfortable or uncomfortable.

Now you take a cow that has been used to a warm stable, and has been fed in such a manner as to open her pores, and let that cow out on a cold day to stand around and there will be trouble. Such a course of treatment would not be at all proper for that cow. The cow is not comfortable and cannot do well while remaining in that condition. That is all there is to it. It is just so when you get to the point of palatability. Some things may contain but a small percentage of goodness, according to the figures that the professors give us, but there may be something about that kind of food that cattle like, and when that is the case there is more than just a small percentage of goodness in that food. The animal likes it. There is evidently something in the nature of the animal which prompts it to eat that food. It makes the animal comfortable. That is the point.

Now I think that the Secretary has something to say and then we will adjourn.

Secretary BROWN. I hope no member of this convention will go away from the hall without looking carefully at the specimens of the gypsy moth and the brown-tail moth which are on the table in the rear, which have been preserved by the Connecticut Experiment Station for our instruction. I want you to look at those specimens carefully so as to be able to identify them, and when you discover them in the State of Connecticut, as Dr. Forbush says we surely will within the next five years, — as soon as you discover specimens of either the gypsy moth or the brown-tail moth in this State, I want

you to report it to the State Entomologist, Professor Britton of New Haven, without delay.

Convention adjourned to 8 P. M.

EVENING SESSION.

December 14, 1905.

Music.

Convention called to order at 8 P. M., Vice-President Seeley in the Chair.

The PRESIDENT. The Connecticut Board of Agriculture has been in the habit of saving the best part of its program until the last. Now you know the ladies must have their say sometimes, and the topic for this evening is something peculiarly within woman's sphere, and that is, the necessity of our having some knowledge of what we are eating and drinking, and how it shall be prepared for us. That is a very important subject, and I am very glad to introduce to you this evening Mrs. Sara Walrath Lyons of New York City.

WHY PRESENT CONDITIONS NECESSITATE A KNOWLEDGE OF THE DIETETIC VALUE OF FOODS.

By MRS. SARA WALRATH LYONS, NEW YORK CITY.

Mr. President, Ladies and Gentlemen:

Your honored Vice-President's introduction of me this evening leads me to appreciate the fact how more and more thought is becoming revolutionized on the subject of woman's rights. That woman's sphere of usefulness, as instanced in the past, is not now confined wholly to the home and fireside, but that now when she feels that she has some important truth to present — some important message to give to the world — it is quite the proper thing for her to mount the platform and give it.

As the varying conditions of life bring change in thought regarding woman's sphere of usefulness so of necessity must they effect a change in the ways of living. This is the reason why I have taken for my subject this evening "Why Present Conditions Necessitate a Knowledge of the Dietetic Value of Foods."

There are many important reasons why a knowledge of food's dietetic value is necessary, but the two preëminent reasons consist in the fact, first, that large amounts of adulterated and preserved foods are placed on the market utterly unfit for human consumption, and secondly, that one's diet cannot be of a nature conducive to health without a knowledge of food's chemical composition and use in the body.

But not only is it necessary to have a knowledge of food values in the selection of foods but this knowledge of food values must extend to their preparation. The best and purest of foods, prepared in an indifferent way with little or no thought regarding their digestibility, naturally will not yield their full nutritive value. Neither is this condition possible where food is imperfectly masticated. We go through life so carelessly indifferent, making use of all things supplied us by the hand of bounteous nature in such a matter-of-fact way, that we do not pause to consider the origin or source of such, but take it for granted that if we eat when hungry human nature will care for itself. This would, no doubt, be the case if not constantly sinned against beyond the point of endurance.

The attitude usually assumed in the selection, preparation, and consumption of food is one of indifference except, perhaps, as it may appeal to the eye or palate. Mind governs man in thought on other subjects, why should it not govern him in the selection of his food? This question, so full of vital importance, I leave with you to consider.

Hurry, worry, and bustling activity characterize the life of most Americans. There seems to be no time for the observance of those things governing health, and it is only when man is brought to an abrupt standstill by illness of some kind that the question in all its phases is considered.

One of the worst habits that the American people have contracted is that of bolting their food instead of eating it in a rational manner with due regard for its mastication. Three

times a day this cramming process takes place and with a sense of duty well done man rises from the table without a thought of wrong doing or that a physical sin has been committed.

But not only have we formed the habit of bolting our food, but we have also formed the habit of taking tea and coffee with our meals. The use of tea and coffee with food doubtless originated from the fact that they are stimulating, but now this thought is greatly overlooked and their greatest virtue seems to consist in the fact that they are useful in washing food down the digestive tract. This does away, in a measure, with the necessity for mastication. When the necessity for a thorough mastication of food is ignored the first step in the process of digestion is also ignored, which I shall endeavor to show you later, and although kindly nature may endeavor to endure this abuse for a while she nevertheless resents it and with good reason.

The best beverage that I know of is cold water. It should be drunk freely between meals, but not so as to interfere with food's digestion. The free use of water is to life a necessity. That of tea and coffee is not and the less one drinks of these stimulating beverages the better it is for them. Americans need no stimulant, as they are far too nervous a race of people to use them. What they do require is more hours for rest and sleep, which does away with the necessity. Hot milk, but not that which has been boiled, if sipped slowly, will stimulate and refresh tired nature when solid food would prove objectionable. It is always advisable, in using milk, to think of it as a food and the jaws should work in a manner similar to the masticating of a solid substance. This is necessary in order that the digestive secretions may flow to act upon the solids which milk contains.

When milk is hurriedly drank, or taken into the stomach in an ice cold condition, there is danger of severe digestive disturbance. The secretions of the stomach being acid and milk being of an alkaline nature it is at once converted into a curd, while the more hurriedly it is drank the larger the curds. If it is taken when in an ice-cold condition, it checks the flow of the digestive secretions and continues to do so until heated to the body's temperature.

Cocoa is also a liquid food and should be masticated just the same as milk. As cocoa powder contains a large per-

centage of starch, part of it a natural constituent and part a form of adulteration, it should be mixed with water and well cooked before the hot milk is added and then served without further cooking. Milk and cocoa, and of course water, should be the only beverages allowed children. Mothers should give more thought to this habit of allowing their children the use of tea and coffee with food; as they also should of allowing them other forms of stimulating beverages, for "As the twig is bent the tree is inclined," and false habits of life, inculcated in early youth, are almost impossible to eradicate in later years. Not only does the use of tea and coffee produce with the child nervous disorders and so a weakened, frail physique, but in time a desire comes for stronger beverages. This desire is also fed unthinkingly by brandy sauces, by brandy in fruit cakes and puddings, in mince pies and in brandied peaches, etc., while the free use of spices and other stimulating condiments is also to be deplored. "Habits are the crutches of old age," and we lean upon them more and more with every year. In early youth is the time to form right habits, and if mothers will but recognize the important part that diet plays in the destiny of their child, I am sure that many of the evils so sadly deplored will cease to exist for lack of fuel to exist upon. Many times I have been asked, "Do you think it possible for one with fixed habits in life to change them, to form new ones?" We are never too old to learn new and better ways of living, and where there is a strong determination to do so false habits can be gradually overcome, until, with time, an entire change has been made in one's method of living.

In the committing of physical sins the individual committing the sin is not the only one to suffer. Everyone near and dear to the individual must suffer, and with ill health in the home there can be no cheeriness in its atmosphere. A strong, healthy stomach is one of life's greatest blessings, but we do not consider it as such until too late. Parents desire only good for their children, still they many times encourage them in those things which they know to be wrong, and as a result there are but few children but what are ailing with some form of stomach trouble. We see the results in their frail physiques. Is it not time to inquire into such conditions, to study cause and effect?

How often we hear the remark that a child is "a natural born imitator," and so he is. He observes his parents at the table, as they hastily consume their food, and thinks he is privileged to slight himself in the same way, which he straight-way proceeds to do with an alacrity often surprising.

In all that I have heretofore said I have tried to impress upon your minds the fact that the digestion of food begins with its perfect mastication. Our teeth were given us by the Divine Creator for the purpose of grinding our food, and by so doing to prepare it for the stomach's digestion. It seems, with many, so difficult a thing to remember that it's the action of the jaws that causes the salivary glands to work and that it is their digestive secretions upon which so much depends. After food is swallowed it is beyond man's control. The muscular walls of the stomach do their best to convert into nourishment that which is given them to digest, and if they fail in their task we alone are to blame.

The digestive secretions of the stomach being acid these secretions can only act upon the proteid foods or such foods as the lean of meat and fish. Eggs, milk, cheese, and the gluten of wheat, peas, and beans are also acted upon by this acid secretion, as is the proteid of nuts. Starchy foods are not digested in the stomach, nor changed by its acid secretions at all, as their digestion begins in the mouth by the action of alkaline secretions. The secretions of the mouth and of the lower stomach, or duodenum, being alkaline they produce the form of ferment necessary to digest starch and which converts it into a form of sugar assimilable as nourishment.

From all this you cannot fail to perceive the great necessity of a perfect mastication of food if you would avoid digestive disturbances. Hot muffins, biscuits, griddle cakes, and all other doughy substances, even though well masticated, produce irritating effects in the stomach. They form, by its action, a doughy ball impossible for the digestive secretions to penetrate. The next step in the digestion of food is when it passes on and out into the duodenum, where the starch of the food is acted upon by the secretions of the bile and pancreas and by these secretions converted into sugar.

When the stomach is overtaxed by an improper selection of food, or by over-eating, its digestive forces naturally weaken and it is but a step to dyspepsia. The taxing of it with hot,

doughy substances is a thing to be avoided and not cultivated if health is a consideration. You can readily perceive from these facts that a person can starve while seeming to be well nourished. The proteids are what we depend upon to build up the human structure. Inability, through any cause, to obtain these elements from food breaks down the muscular walls of the body and the tissues starve in their effort to support life.

A mason would never think of using poor mortar in cementing the walls of a building together. Should not we be just as particular with the human house, or body, and select and consume only that form of nourishment which is necessary for its growth and strength? Nature protests when sinned against but we do not always heed. Indigestion is but the warning voice of dyspepsia; dyspepsia but the forerunner of disease; still we not only continue to improperly masticate our food, but to improperly prepare it.

Over eleven thousand million pounds of meat is consumed in this country every year, due, to a great degree, to a lack of knowledge in preparing vegetables in a palatable manner. The preparation of delectable pastry, I am sorry to say, seems to be a stronger point for consideration. In the cooking of even the plain and homely potato there is an art. This vegetable is a much abused article of diet, for without a knowledge that the best and most nourishing part of the potato lies next to the skin, it is thickly pared, and usually cooked in a way not intended to elicit words of appreciation.

In preparing potatoes for the table they should be scrubbed well with a vegetable brush and after cutting out all bad portions they should be cooked with the jackets on. If they are to be boiled drop them in hot water, after seeing that the potatoes are about equal in size, and keep them constantly and steadily boiling until done. This condition is only attained when the starch cells of the potato burst and it is only then that the potato will pierce done and is fit for food. When this condition has been reached they should immediately be drained and placed in a hot tureen and covered with a towel of loose texture in order that the steam may escape and the potato remain dry and mealy. In baking a potato there should be maintained a low degree of heat, for then its skin will peel off in a thin coat and the most nutritive part of the potato be preserved. In ascertaining whether the potato has baked suffi-

ciently long press it between the hands, and if it yields readily to the touch and bursts its jacket in the pressing, this condition has been reached. It should then be taken from the oven placed in a hot tureen and kept, until served in a manner similar to the boiled potato. The bursting of the jacket of the baked potato is as necessary as with that of the boiled, as this enables the water it contains to pass out and off as vapor. If this steam condenses, or is unable to escape, the potato naturally becomes heavy and soggy and in such a condition unfit for food. We thus see that science applied even to the cooking of a potato is well worthy of consideration. When we go still further and analyze the potato, finding that the albuminoids and the most nourishing parts lie next to the jacket and that these nourishing parts have been ruthlessly cast away, or fed to the live stock, then will we begin to appreciate the fact and to understand that the preparation of food to yield nourishment is not a small thing to consider. The consideration of such should be the delight of every housewife. The kitchen is the laboratory of the home. As such it should be considered, for it holds much within its environs. The health of the family, to a great extent, depends upon the one who prepares the meals, and with a full appreciation of these duties no wife or mother should ignore them.

But not only will we consider the food value of the potato but that of other vegetables. Take, for instance, cabbage. Usually in cooking, or even in using the vegetable raw, the coarse outer leaves are used in connection with the tender inner portions. All this is wrong, for the tough outer leaves of any plant or vegetable are always difficult, if not impossible, to digest, and are productive of digestive disturbance whenever the attempt is made. Feed these coarse outer leaves to your live stock, to your domestic animals, for their nerve energy will not be depleted in digesting them. Conditions of life are such that you have no nerve force to spare in the effort.

Not only is it necessary to observe the preliminary preparation of cabbage, but its cooking. It should be boiled in plenty of water in an uncovered kettle, and as soon as the vegetable pierces tender, drained of the poisonous acids which the water contains and then placed in a hot dish. Vegetables should never be served underdone, neither should they be served overdone. One condition is about as bad as the other, for neither

condition tends for health. The coarse outer leaves of salad plants are as objectionable as those of cabbage and these should not be used as food either. Neither should the coarse outer stalks of celery. A little forethought in this respect will go a long way toward promoting right bodily conditions.

It is the observance of these little things that tend so much to keep us in good physical condition. Who has not felt the effects of improperly cooked food, or the miserable after effects of such food? Not only does the eating of improperly cooked food irritate the whole digestive tract, but it also acts as an irritant to the mind, and in spite of our best endeavors it is impossible to concentrate thought, or to make any great mental effort. We are ready to admit that something is wrong, but we are seldom ready to admit that this something is our food. When we do see and admit the fact that as we are physically, we are mentally, then only will we earnestly consider the conditions for health, and so considering, strive to observe them. That "health is wealth," is a true saying, while indifference to food's dietetic value cannot help but be the foe to true progression. Ignorance is the mother of vices and the sooner we admit that the educational system of our country is entirely wrong in ignoring the physical conditions of the growing youth of this country the better it will be for all future generations. It is only when such conditions are observed and amended that we can hope for real improvement in the human race.

America is known as the great meat-eating nation. Statistics prove that we annually consume over eleven thousand million pounds of meat. Why this immense consumption? In my opinion it is due to careless indifference in the preparation of vegetables as food. No one can be expected to eat with relish a soggy, watery and insipid tasting vegetable. It is not palatable and, if eaten at all, needs much seasoning to pave its way to favor.

Badly cooked vegetables, as I have endeavored to show you, are badly digested, and instead of yielding nourishment introduce into the system poisonous vegetable acids harmful in the extreme. To do away with this immense consumption of meat, which, in many instances, acts as a poison in the human system, more attention must be given to the cooking of vegetables. While it is an art to properly cook meat it is an even greater art to cook vegetables. This fact is plainly demonstrated in

the serving of food at either hotels or restaurants, for meat is almost invariably served cooked in a palatable manner, while vegetables require the use of sauces and spicy condiments to make them edible. The usual thing with the frequenter of restaurants in ordering a meal is to order a steak, accompanied with fried potatoes and coffee. Fried potatoes are admittedly indigestible; the coffee is stimulating, and so, to a degree, is the meat.

To one confined to indoor pursuits, and it is usually this class of people that select such a diet, such a meal is little better than poison. It is impossible for fried potatoes to be perfectly digested under the best of conditions, while the waste substances which fill the blood vessels of animal flesh cannot help but be of a poisonous nature no matter which way we look at the question. There is really but a small per cent. of meat consumed in this country that is fit for human food. This important fact was made known to me not long since by a prominent veterinary surgeon whose years of experience lend strength to his words. Tuberculosis prevails amongst animals to an alarming extent, and even when seeming to be in the best of health they are suffering from this awful disease. When animals are affected with tuberculosis the whole muscular structure is naturally diseased and through the laxity of laws governing the sale of such meat and inability to trace the origin of such, it is not only placed in the stores for sale, but consumed by the many who have no idea of the wrong perpetrated upon them.

Vegetarians wisely substitute nuts for meat. Their argument is that it is not humane to destroy the life of animals. While this is a strong point to consider and to find favor in our minds, we should not ignore the physiological side of the question, for when it is admitted by physicians, who have given much study to the subject, that meat eating conduces to various forms of disease, in fact, creates disease, it is time for man to seriously consider whether it would not be wiser to abstain from meat eating altogether. For my part, if you will pardon this personal allusion, I seldom eat of animal flesh at all. I find that I can keep in the best of health and strength without it. The albuminoids found in meat and which act as a repairer of the tissues of the human body can be found, without eating diseased waste substances, in eggs, nuts, and the gluten

of wheat; also in peas, beans, and lentils. These, as I have mentioned, are known as the proteid foods, with the further addition of milk, cheese, fish, and meat. We require only one-fourth part of the proteid elements in arranging a diet, and that man or woman that consumes more food than the body requires to build up and repair its waste, sows the seeds of disease apparent in the years to come.

The eating of meat not only introduces poisonous waste in the human body, but the digested fibre of the meat clogs the blood vessels and by so doing interferes with the circulation of the blood, and the functions of the various organs of the body.

If all this array of facts is not convincing proof that a vegetable diet is preferable, I wish you one and all would experiment with yourselves and judge, by means of such experiments, whether health is not yours for the seeking. I am sure that you will find a trial of a few months convincing proof that better health attends a vegetable diet. Wise mothers will not educate their children to the use of meat, but will give them instead nourishing soups of peas and beans and good whole wheat bread. The cracked or whole oat is one of the best of foods for children, as is also corn meal, which can be used in a variety of ways. Time should not be considered as wasted in arranging a diet; for health, the greatest of earthly blessings, attends well directed efforts in this direction, and a little thought given each day as to what to eat will yield a harvest of blessings.

Often I have had said to me, "but how shall I find time to arrange a diet adapted to the individual needs of my family? I haven't time for such, my time is so taken up." Yes, we are a busy people. I never dispute this fact, but are our energies all wisely directed? Have we not drifted into the habit of doing many senseless things which it would be better if left undone? How about the time spent in concocting various dishes for the table which take so much time and thought in their preparation? There is scarcely a day of my life but what I am assured by some wife and mother that her family cannot do without pies, cakes, and pastries, to say nothing of salads, mixed pickles, chow chow, etc., that are thought necessary and substantial foods. I invariably ask, are you not to blame for all this? Have you not made the cross that is laid with so heavy a weight across your shoulders? If mothers educate their children with a fondness for such food can they expect

anything else but that these unnatural, perverted tastes will follow their children through life? But mothers, somehow, do not seem to see the errors of this training or why their children are not physically fitted for great mental strains or efforts, and they only will or can see, when they understand the chemical composition of foods and the full meaning of dietetic values. It is an old adage that tells us "that man is as the food he eats," but the literal meaning of the saying is but little understood. Let us see if we can trace its origin.

Foods, learned chemists tell us, are composed of elements found in the soil of the earth, which the little rootlets of growing vegetation take unto themselves to thrive and grow on. The kindly hand of nature supplies within its depth everything necessary for the development and growth of plant life, and these elements, compounded in the laboratory of Mother Earth, are given to us as food in the forms of starches, or, as chemically termed, carbohydrates; as proteids, or nitrogenous compounds; fats and mineral substances.

In these various food groups we find different elements, the office of some of these elements being to build and repair the tissues of the body. The foods that contain these elements are known as the flesh builders, or the proteids. Another group, the carbohydrates, yield heat and energy, and still another supplies the material from which the bones, teeth, hair, and nails are built. Chemists determine these facts by analyzing foods and studying their effect in the human body. They have also found that the human body is composed of like and similar elements as found in food. These elements are of many and varied kinds as supplied by nature, but I will only name a few of the most important ones. Some of these, you will observe, are gases, some are solids, while others are of a mineral nature. Of the gases we have oxygen, nitrogen, and hydrogen. Familiar as we are with the thought that nitrogen and oxygen constitute the air we breathe, we have still to learn that these gases form a part of our foods and likewise form a part of the human body. The gas, or element nitrogen, is found in all nitrogenous foods, these foods being usually classed as the proteids. It is this element in food upon which we depend for strength and muscular development. The gases, hydrogen and oxygen, combined form water.

In the carbohydrates or starches, and also in the fats, we find the solid carbon, which burns in the human body with great

heat. Should we toast a slice of bread until it became charred and blackened we would have as a result charcoal, or the solid carbon. Burn this charred piece of bread or reduce it to ashes and we have the mineral substance found in the solid, carbon.

Besides the elements oxygen, nitrogen, hydrogen, and carbon there are many other important elements found in food, such as phosphorus, sulphur, chloride, sodium, fluorine, silicon, manganese, magnesium, copper, and iron. All of these have an important part to play in the internal economy of man, and if these elements are not supplied in the proper ratio to the body's requirements some part of the human structure must suffer.

It is here that we are led to see man's perversion of the work of nature. He separates and divides the component parts of foods, introducing in the market such a variety of substances that the brain grows bewildered with the effort of selecting, and by so doing gives us as food an artificial substance, devoid of the necessary elements for sustaining life. To illustrate: in the past, with the primitive methods of milling, there was but one way of grinding wheat, and that was by crushing it between two flat stones. The whole wheat grain or kernel was crushed in this way just as nature had grown it for use, and contained within its bran coats all the elements necessary to sustain life. At the present time we have countless methods of milling, and countless grades and kinds of flour. The work of nature is perverted and unless one has a knowledge of the dietetic value of foods they know not how to help themselves.

In the germ of the wheat are found the soluble phosphates which nourish the brain and nerves; in the bran coats, which includes the gluten of the wheat, are found the elements which build the bones and teeth and those which build up the fleshy structures of the body. When these bran coats are removed, as in the milling of flour today, what is the result? We have left only that part of the grain known as the carbohydrates or starches and which are only useful in the human body as fuel. That is, they yield heat and energy, but do not act as a repairer of the body. The only thing possible to do under such circumstances is to substitute the elements taken from the wheat and in this way secure a balanced food substance. It is this separating of the natural food products that is detrimental to health and the substituting by manufacturers in the separating,

of inferior substitutes. Not only are inferior substances substituted but adulterated ones, so that one hardly knows what they are purchasing as food.

For instance, skimmed milk cheese is filled with lard as a substitute for the butter fat taken away and which is made into sweet cream butter. The cheese is then sold for full milk cheese. Various kinds of baking powder and pulverized sugar have a large percentage of crushed stone and rock, while it is impossible to purchase pure syrups any more. Most of the syrups sold consist almost wholly of glucose, and it is this substance that is sold in glass jars as strained honey. Glucose is a thick syrup produced from the starch of corn by the action of sulphuric acid and an artificial production that it is well for man to let alone. It also forms a part of most jellies and jams, while the so-called preserved fruits sold in buckets have a large percentage of it, but usually not the faintest suspicion of fruit. Neither, as a rule, do soda water beverages nor ice cream preparations. Hay seed is used as a substitute for berry seeds to further deceive, and the law permits such frauds and we, as individuals, ignore them!

Ground spices are found to be largely adulterated with cocoa nut shells, olive stones, wheat brans, ground rice, etc., and I could go on enumerating at length, for there is scarcely a food substance in the stores for sale but what is adulterated and if not adulterated, preserved, for it is only the first or best grades of vegetables, fruits, and meat that are not preserved. Fruit in season and perfectly ripened requires no preservative, but the over-ripe and partly decomposed fruit does, as does that which is under-ripe. Fruit necessarily preserved by the use of chemical preservatives is not fit for use. No one cares to eat decomposed or unripe fruit in its natural state, and surely no one cares to eat such fruit that has been slovenly canned with the addition of a preservative to destroy the life giving elements in the blood.

It was only last year that Dr. H. W. Wiley, Chief Chemist of the United States Department of Agriculture, demonstrated to the world that food preserved by the use of borax or boric acid was injurious to the human body. He experimented with several young men and for several months the experiments were continued until it became a demonstrated fact that the use of borax or boric acid, used as a preservative, was detrimental

to health. Even half a gram a day was found to be injurious, if continued for any length of time.

I fancy I hear you all asking, what then can we eat? Is there any known article of food not adulterated? As conditions now exist there seems to me but one open way to pursue and that is to adopt, as far as possible, the simple, primitive methods of preparing foods as in the past. Use of the freshly grown vegetables and fruits instead of the canned products. To save time in the preparation of fruits and vegetables for cook-the housewives having formed the habit of using canned foods freely and think nothing of using them the year round. The original use of such was to help tide over from season to season when fresh vegetables and fruits could not be procured, but this fact has been overlooked.

Not only should we eliminate canned fruits and vegetables from our diet, but meat, as largely as possible, for reasons already stated and because it is usually preserved with boracic acid. This acid preserves meats' color and by other artificial devices it is made to seem plump and fresh. Spices should be used as little as possible but when used one should purchase the unground berry. By adopting this plan of action you avoid their adulteration. Whatever you purchase as food get the best procurable. The best is none too good, and if we expect to derive sustenance and strength from our foods we must select those that will make such a condition possible. We should not expect results if we are indifferent to them. What nature requires for health is pure, wholesome, unadulterated foods. Simplicity of diet and preparation of foods should be the watchword in every home.

But there are other things for us to correct and that is the methods employed by food manufacturers to deceive. For the past twenty years efforts have been made to induce Congress to pass a pure food bill. Such a bill has been regularly introduced each year, but of no avail. Last year it succeeded in passing the House of Representatives, but the Senate laid it aside as usual. It would seem that our wise and learned Senators are not wasting time and thought on the health of the nation, and but little does it seem to concern them how many lives are sacrificed each year through their indifference to this bill. At least this would seem to be the case, for I have Dr. Wiley's word for the truth of this statement, "that last year's

pure food bill was laid aside by the Senate while they took up for consideration a bill relating to the misdemeanors of two sailors." The laying aside of a bill is but a subterfuge resorted to to get rid of a bill, and so year in and year out some ruse is resorted to with the pure food bill until patience with the American people is ceasing to be a virtue. Manufacturers of food products for the first time are beginning to show alarm and well they may. Let us all earnestly work for the passage of this bill, for with its passage lies the health of the people. The health of its people should be the first and predominant thought with a far-sighted government, for health is the pulse of a nation's growth and the backbone of a nation's greatness.

Not only does pure blood produce conditions for health, but it also breeds healthy thoughts as it is only possible for pure blood to do. As thinking people let us seriously consider these problems and resolve that impositions which reflect on health shall not be countenanced or supported. It is only by co-operation that we shall succeed in overthrowing this greedy monopoly of our rights, so let us co-operate in every way possible with Senator Heyburn, and by so doing win for truth, for right and justice! Over two billion dollars, it is said, go into the pockets of unscrupulous manufacturers every year. Not only do they rob us by compelling us to pay our hard earned dollars for an adulterated food substance, but they also enrich themselves at the expense of the health of the people. Such conditions should not be tolerated, and I, for one, intend to give my best efforts to awakening thought and creating sentiment against them. Our representatives in Congress are there to do the will of the people. Let us signify to these Senators, that represent our States, that it is our desire that they work for the passage of this "pure food bill." When they become convinced that we are in earnest in seeking its passage, only then will they become active and the bill become a law.

From all that I have said to you this evening I am sure that you must see that the physical, mental, and moral of man work hand in hand. That they form a trinity which in this world cannot be separated one from another. The body is the temple that holds life's treasures, and as such it should be carefully nurtured, for it is only the physically strong body that is capable of supporting great mental efforts. This fact, as I have stated, seems to be ignored in the training of children and

as a result, and at an early age, many succumb to sickness and disease. The physical forces have not been capable of sustaining the strain of prolonged mental efforts and so a bright useful light goes out. It is thus seen that abnormal conditions of body produce abnormal conditions of mind. This is a law of nature. The physical, mental, and moral of man degenerate with one accord. Let us strive for the normal condition, remembering that God created us whole, and by thus striving create harmony of life's forces — Health and Happiness.

Secretary BROWN. Mr. Chairman, before we close, I want to say just a word. This subject of the pure food law is one of vital importance, and it may be said that the laws of this State have wrought something of a revolution in the modes of adulteration, which is no longer of a dangerous character, especially when compared with that which was carried on here a few years ago. Formerly, foods were adulterated here without regard to their effect upon the human system, but at present, according to a paper which was read by Dr. Jenkins in New Haven last week, the methods of adulteration have been changed so that poisonous materials are no longer used, but the percentage of adulterations is no less than formerly.

Mr. President, as you know, we have now been for three days practically the guests of the Town of Windham, and of the City of Willimantic, and it is with great pleasure that I desire to offer a resolution, extending to the Town of Windham, and to the City of Willimantic, and to all who have aided in making our convention here a notable success, the sincere thanks of this Board of Agriculture.

The PRESIDENT. You hear this resolution as presented by the Secretary. It is duly seconded. All those in favor of passing this resolution of thanks will signify by saying "Aye." It is unnecessary to call for contrary minds. It is unanimously passed.

I think there is no further business, and this convention will now stand adjourned.

In Memoriam.

Theodore Sedgwick Gold, former Secretary of the Board of Agriculture, was the son of Dr. S. W. Gold of Cornwall, Conn.

Born in Madison, N. Y., March 2, 1818, died March 20, 1906, at his home on Cream Hill, where he had lived for sixty-four years.

When he was very young the family returned to Connecticut and lived in Goshen until after his graduation from Yale in 1838.

After teaching for three years he moved to the ancestral farm in Cornwall and with his father established an agricultural school, which they continued for twenty-four years.

It was through his untiring efforts and belief in the results to be obtained that the Connecticut Board of Agriculture was established in 1866 and he was made its first secretary, which office he held continuously for thirty-four years. Mr. Gold also, with the aid of others, secured the establishment of the Connecticut Experiment Station, the first in this country, and it has proved its merit by holding first rank with any in the world.

He was officially connected with the Connecticut Agricultural Society from its beginning in 1853, for twenty years Trustee of Storrs School and Agricultural College, Member of the Board of Control of the Connecticut Experiment Station from its establishment, Fellow of the A. A. A. S., Member of the Am. Pom. Soc.; Am. Forestry Asso.; National Geographic Soc.; Am. Hist. Soc.; Conn. Hist. Soc.; Conn. For. Asso.; S. A. R., and Founders and Patriots.

For nearly half a century he lectured on agricultural subjects, having delivered a course of lectures at the Sheffield Scientific School in 1860. At one time editor and for more than sixty years a contributor to the agricultural press.

Mr. Gold was always a student from his infancy to his last days, an extensive reader on subjects relating to science and the arts. He had a wide acquaintance with men of learning and prominence throughout the country.

As a farmer always progressive in his methods and an early importer of blooded stock.

As a man, life-long friendships attest to his worth and steadfastness.

As a teacher he won the love and confidence of his pupils.

In his family he was universally loved and revered. In the Church at North Cornwall, where he worshiped for sixty-four years and held the office of Deacon for over thirty years, he always stood for what was highest and best.

Mr. Gold lived to the ripe age of eighty-eight with powers of mind unimpaired and with interest unabated in all things connected with his farm, the State, and all mankind.

The substance of the following paper was presented at the annual mid-winter meeting of the Board of Agriculture, held in Hartford December 14-16, 1904, but the Secretary was not at liberty to publish the stenographer's report without revision by the author, which serious illness prevented until too late for insertion in report for that year.

The importance and permanent value of the paper amply justify its insertion here and the thanks of the Board are due Prof. Gregory for revising the stenographer's notes for publication.

THE GEOLOGY OF CONNECTICUT IN RELATION TO ITS WATER SUPPLY.

BY HERBERT E. GREGORY.

Professor of Geology in Yale University.

Whatever may be said of man's intellectual and spiritual endowments he is, nevertheless, an animal, and as an animal is controlled by his geographic environment, and he must adjust himself to temperature, rainfall, and other conditions of climate, and is dependent upon the plant and animal life about him, which in turn are dependent upon the soil, water, and food supply. Man is not the swiftest animal, nor the keenest scented, nor the keenest sighted. He is not the strongest animal nor the longest lived. He has won out in the struggle for existence and has established his supremacy at the head of the animal kingdom simply because he is better adjusted to his environment. Man has been remarkably successful in modifying and overcoming his natural environment, but evidently within limits. He cannot prevent the lightning, nor make a flood plain where lofty mountains now stand, nor can he change a desert into a region of heavy rainfall.

No factor has exerted such control over man's advancement, civilization, and migration as the supply and character of water. The normal human adult consumes daily about $4\frac{1}{2}$ pounds of simple liquids, and when it is considered that this is the chief part of his food supply, and at the same time, the part which is most liable to contain harmful organisms, the importance of water supply is readily seen. Furthermore, the plants on which man depends for food supply require enormous

amounts of water to bring them to maturity. It requires 310 tons of water to produce a ton of corn, and in order to produce a ton of dry oats the oat plants must drink 522 tons of water. On the average it requires 325 tons of water to produce one ton of dry matter in the common field crops.

The value of a given water supply for domestic purposes varies with the locality and with the increase of population, and accordingly during the process of settlement of the United States different sources of water have been used and abandoned in turn. The first European emigrants were satisfied with any of the numerous streams of fresh water which enter the Atlantic from the well watered slopes of New England and the coastal plain. But the streams were muddied during floods and in times of high water the water courses were burdened with accumulations of organic matter from swamps and marshes. To remedy this defect cisterns were built to store the rain water, as is now common in Bermuda and certain tropical regions. As the pioneers made their way westward their movements were controlled by the water supply. Springs determined the location of camps, and many a log cabin built by some practical frontiersman near an abundant spring of pure water was the nucleus about which has grown the permanent village. The origin of the water in the spring and its possibility of exhaustion did not attract the attention of the settler, and the result was that many of the springs became contaminated or dried up. Certain springs known to the Connecticut pioneers seem to have disappeared entirely from the landscape. With the change from hunting and lumbering to agriculture a new problem in the water supply was presented. Much of the best tillable land was found to lie above the water courses where there were no springs; and furthermore the cultivation of the uplands resulted in polluting and decreasing the flow of the springs lying at a lower level. To remedy this defect springs were deepened and holes were dug where seepage indicated the presence of water near the surface. These were the first wells. As the demand for an easily accessible supply of water increased wells were dug without regard to surface indications and this artificial supply soon replaced the natural supply from streams and springs. The farm or the village home without its well was a rarity, and the water supply was satisfactory both as to quality and quantity. However, as gen-

eration succeeded generation and the population increased, the soil beneath barns, houses, and fields became charged with certain poisonous products which found their way into the wells. The surface wells of most thickly settled regions are now subject to contamination, but the danger is not readily recognized, for certain kinds of filth increase the clearness and sparkle of the water and add an agreeable taste. The old oaken bucket is no longer a symbol of purity. Windmills, steam pumps, and iron pipes are much less poetic, but far more conducive to health. At the present time the nature of the water supply is being carefully studied and the tendency everywhere is to sink wells of small diameter and of great depth and wherever a sufficient number of inhabitants makes it profitable to store up the water in reservoirs and to keep it constantly under the surveillance of trained scientists.

SOURCES OF WATER SUPPLY.

The water supply of the earth is included in rivers, lakes, and ground water. In the first instance, the world's entire supply is the rainfall, which is controlled in its amount and periodicity by the temperature and prevailing winds, so that there are distributed over the earth regions of no rainfall, arid regions, humid regions, and regions of excessive rainfall. The rainfall measured during one year in Indio-California was less than 1/10 of an inch, and in Northeast India, at Assam, 905 inches fell in a year.

Rivers. Rivers form the first natural water supply. They develop on land surfaces wherever there is a rainfall and the rocks are not so porous as to take up all the water. The size of the stream, its system of tributaries, and the shape of its valley depend upon several factors, and the development of a complete river system is a long and complicated process. When water falls on a new land surface it is a stranger — no rain-drops have been there before it and no rills are marked out to rivers and thence to the ocean. It flows down any offered slope in simple channels — about equally spaced. It pays no attention to the character of the rock floor beneath — hard rock and soft are equally acceptable. As the streams enlarge, however, they soon learn to select the softer and less resistant rock for their channels, and as time goes on they become more

and more adjusted to the rock structure beneath. The Farmington River, from Farmington to Tariffville, is in soft strata; so is the Housatonic for some distance south of Canaan. At Tariffville and New Milford these same streams cut through hard rock.

Not only the river system but the shape of a river valley itself depends upon the character of the rock forming its bed. The form of the valley also depends upon the length of time a stream has occupied its present channel, *i. e.*, the age of the valley. In accordance with rock character and age, rivers have cañons and gorges or wide, open valleys. Rivers differ from each other and parts of the same river valley show marked difference in shape. The Scantic is very unlike the Naugatuck. The Quinnipiac Valley at Milldale is almost a plain, but at South Meriden there is barely room along its banks for a wagon road. The valley at Milldale is some millions of years old; that at South Meriden but a few thousand. The Connecticut has occupied its present channel for a few million years and has cut a rock-walled valley below Middletown. During the same time it has widened its valley at Hartford until it stretches from Bloomfield to Rockville. Below Middletown the Connecticut found hard rock, while above that point it encountered soft material. Rivers are found in Connecticut in all stages of development.

Lakes. Hills, valleys, rivers, and lakes are not permanent topographic forms, but are features of an ever-changing landscape, and it is only by poetic license that we may speak of eternal vales and hills "rock ribbed and ancient as the sun." Lakes have a shorter life history than most scenic forms. They are full-grown when the valleys are still young, and they die long before the hills have reached maturity, and before the rivers have developed their greatest power. It is only when lands are in their infancy that lakes abound, before the enemies which destroy them have attained full strength. Lakes are hindrances to the rain, frost, wind, and river in their work of land sculpture. So, while they may be ornaments of topographic youth, they must be sacrificed to the demands of active life struggle.

Lakes are not distributed haphazard over the world, but in accordance with definite geological principles. In the United States the lakes are most numerous on the plains from New

England to North Dakota. The drainage system in this region is all new. Waterfalls and lakes, which are always youthful characters, abound. The rivers have not been allowed to complete their cycle of development. The even course of their lives was broken into and they were once more brought back to youth. It is as if they had met with an accident — the accident of glaciation — which renewed the youth of the entire land surface. During the Glacial Age, when the world's winter closed in and the great ice sheet crept down from the north, it took entire possession of the land. Living forms were compelled to migrate or perish. Rivers, hills, and valleys had no choice but to submit helplessly and to see their life work completely undone. Because of its great weight, its slow but irresistible motion, the glacier transformed the landscape beyond recognition. In one place a gorge was cut in solid rock; in another a river system with its thousands of tributaries was completely buried under *débris*. Elsewhere a rugged, picturesque landscape was transformed into a featureless plain. These changes wrought by the glacier in the landscape must endure for ages. Of the rivers which sprang up after the ice had melted some were able to find their former channels, many were not. Some valleys were only partly filled, some completely obliterated. There was thus presented to the rainfall a new surface, and the newly formed streams wandered about over strange lands, and in the absence of well-established drainage many depressions were left without an outlet. The conditions were right for the birth of many lakes; the hollows and pockets filled with water, and the water bodies must remain until mature topography is re-established.

During the Glacial age the United States was covered by ice north of a line running across Long Island, New Jersey, Pennsylvania, and Ohio, and thence west and northwest. Because of the complete change in water channels due to glaciation, the scenery north of the ice limit differs markedly from that south of the line. The southern rivers have regularly developed tributaries and flow in valleys corresponding in character to their age. Northern rivers, especially the smaller ones, have gorges and waterfalls. The southern States have few lakes, the northern have abundant lakes, ponds, and marshes. The Century Atlas maps show no lakes in Delaware, Maryland, West Virginia, Kentucky, Tennessee, Alabama, and Kan-

sas. Connecticut has 216 large enough to be represented on a map of the same scale. Within a radius of 25 miles from Boston there are 180. Minnesota has 476 on the Century map, and Maine, New York, Canada, Michigan, Wisconsin number their lakes by the thousands. In fact the connection between the origin of lakes and the former presence of the ice is so close that the southern extension of the ice lobes could be roughly determined by mapping the lakes.

Ground Water. The water which falls as rain upon the earth is divided into three parts — that which is evaporated, that which finds its way directly into the streams and forms rivers and lakes, and that which enters the ground, to remain there for a longer or shorter period of time. The fluctuation in level of lakes and streams shows clearly the relation of the water bodies to rainfall. The amount of water in the ground is likewise intimately connected with the rainfall. In dry weather the water in wells sinks and in droughts may entirely disappear. Springs are strong flowing, or intermittent, or cease altogether in accordance with the variation in climate. The amount of ground water depends chiefly, therefore, upon the amount of rainfall, which averages between 2 inches and 600 inches a year. Connecticut receives between 40 and 50 inches per year.

The amount of water which enters the ground is dependent somewhat upon the character of the topography and the texture of the soil. If the rain falls gently more goes into the ground; sometimes all of it enters. If the surface of a country is flat it will evidently take in more rain than if hilly, and if the soil is loose and open it will receive more rain than if dense.

Taking the earth as a whole 22 per cent. of all the rain that falls enters the rivers, and the remaining 78 per cent. is divided between that which is evaporated and that which enters the ground. Certain rivers of New South Wales take only $2\frac{1}{2}$ per cent. of the precipitation; some New England streams carry over 50 per cent. The amount evaporated is relatively small and the total amount of ground water is great and varies with the porosity of the rocks and the soil. When marbles of uniform size are placed together it is found that the pore space equals 32 per cent. to 40 per cent. of the solid parts. Theoretically, when the spheres are as compact as possible there is a minimum porosity of 25.95 per cent. and when loosely packed

may reach a maximum of 47.64 per cent. So long as the spheres are of uniform size the porosity of a pile of large marbles is the same as that of small ones. In nature the grains are not like marbles, all of one size, and are not tightly compacted, so that the porosity of sands and gravels falls below the theoretical maximum and above the theoretical minimum. Chalk will absorb two gallons of water for every cubic foot. Sandstone consists of cemented grains and is so constructed that it may hold 20 to 30 per cent. of its weight of water. There is enough water in the sandstone underlying parts of Minnesota and Wisconsin to make a lake covering those States to a depth of 50 to 100 feet. Sand may contain 30 to 40 per cent. of its volume of water, and some of the loamy soils near the surface of the ground have a capacity for even a larger amount. Not only do sands and sandstones contain water, but every known rock contains a larger or smaller amount. The densest granite known in this country, that from Montello, Wis., which was used for the sarcophagus of Grant's tomb in New York, has a porosity of .237, or about one-fourth of one per cent.

Ground water is most abundant a few feet below the surface and decreases in amount from that point downward. At great depth no pores can exist; under the pressure of the overlying rock all spaces, cavities, and pores would be closed. The depth to which any open space in rocks may occur is about six miles below the earth's surface.

So great is the amount of ground water that if it were taken from the surface rocks down to that depth there would be sufficient water to cover the entire earth with an ocean 3,000 to 3,500 feet, equal to one-third as much water as in the present oceans. This great amount of water remains in the ground from year to year, and varies in its amount and nearness to the surface with all the factors which determine climate.

The level below which rock and subsoil are always full of water is the *water table*. This water table is not a horizontal plane but adjusts itself to the topography. In lakes and swamps it is at the surface. It is at less depth in valleys than on hillsides, but it bends upward and downward with hills and valleys, and in a humid region is never at great depth below the surface. Wells sunk below this water table will produce water. In dry seasons the water table recedes from the

surface, and if wells are to be successful they must be sunk deeper. The fluctuation of the water table with the supply of water is well shown in irrigated regions. Here the supply is artificial, in other cases it is natural, but the result is the same, and wells sunk in such a region will be dry part of the year unless they reach a depth below the dry water table.

The water contained in the ground does not remain stationary, but wherever the land is above the level of the sea it has a drift or underground flow, usually in a definite direction. This motion of ground water is rarely in the shape of a definite stream; only in limestone regions where underground drainage has been established do such phenomena occur. In extreme cases, as in parts of Kentucky, all the water flows underground and the surface channels are dry over many square miles. In the case of Kentucky this absence of surface water appears to be no drawback, for other beverages supply the lack, but it is a decided defect in the scenery. Ground water generally forms no streams, but moves gradually and finds its way between the grains comprising the rock. The rate of movement is very slow indeed. In fine sand with a slope of ten feet to a mile ground water will move 52 feet per year. In fine gravel it sometimes attains a speed of a mile a year. By suitable study it is possible to determine the rate and direction of motion of the ground water for any given place. The movement of ground water has an important relation to health. Noxious water may flow for some distance before being purified by natural filtration, especially if it has occupied the same course for many years, and care should be taken in the location of wells. In 1872 a typhoid epidemic broke out at Lausanne, Switzerland, and it was found that the polluted water had traveled through a mile of sands and gravels.

Ground water is returned to the surface naturally by springs, or artificially by wells of various sorts. Springs are usually due to one of three causes: they may be outlets for subterranean streams, like Silver Spring, Florida, or Cascade Spring, South Dakota; they may be located along some crack in the earth's crust and thus be outlets for very deep water supply, like the mineral springs of Virginia, and many Connecticut springs; and finally they may occur at the contact between strata of open texture and water-tight layers. Probably 90 per cent. of all springs belong to this last class. The water

saturates the upper beds down to some impervious layer and then follows this layer out to the surface. Springs located along deep cracks show little or no variation with the seasons. Springs nearer the surface may become intermittent or cease altogether.

With this outline of the source and occurrence of potable water in mind we may now examine some special features of Connecticut geology to see what factors control the supply in rivers, lakes, soils, and bed rock.

Rivers of Connecticut. The river system of Connecticut has a long and varied history. Back in the Cretaceous age of geological time, after the sandstones and lavas of the Connecticut Valley had been formed, the entire State of Connecticut seems to have been worn down to a condition approaching a plain at sea level. Such rivers as existed on the plain wandered back and forth in valleys with gentle grade, and finally found their way into the sea to the east and to the south across Long Island. The plain thus formed seems to have risen from the sea gradually and with a slight tilt to the southeast. On this plain the old rivers were revived and new rivers began their life history. The streams took a general southeast direction in accordance with the slope of the overlying land. Many of the Connecticut rivers have maintained this original direction. The Shetucket, the Hop, the lower Connecticut, the upper Farmington, and the Housatonic River from New Milford to Derby, flow in channels which they inherited from the Cretaceous age. Many of the rivers of the State, however, occupy courses which are not in accord with the structure of the Cretaceous plain. The slope of the State is northwest to southeast from Bear Mountain, 2,350 feet in height, to sea level at Stonington, but many rivers run to the south and to the north in directions contrary to the general slope of the land. The factors which determine the directions of these streams are the structure of the rock on which they flow and the modifications which have been brought about by the presence of an ice sheet. The common brownstone from Portland and Longmeadow and elsewhere in the central part of Connecticut was laid down in horizontal beds and upon them, at three different times, were poured out lava flows 100 to 400 feet thick. These beds have been broken and uplifted so that they dip to the southeast, and subsequent erosion has

developed prominent hills. The Hanging Hills, Farmington Mountain, Cedar Mountain, Saltonstall, Totoket, etc., have thus originated. The rock floor over the entire State has been fractured, cracks and ridges produced running chiefly in a northeast-southwest direction, but also at various angles to that main line of breaking. Streams would follow readily along these lines of fracture and it is believed that many of the larger and smaller water courses of the State are controlled in their direction by the uneven topography produced by faulting. In certain places, as west of Talcott Mountain, the rock floor was of such softness that the streams cut out a valley much more rapidly than in other places, and regardless of the original slope of the land, the stream made its way along the line of least resistance. Thus the Farmington, which now enters the Connecticut at Windsor, appears to have formerly flowed through New Britain and later entered the Sound at New Haven. By the process of glacial damming and the filling of channels many of the smaller Connecticut streams have been greatly modified in their direction, and flow in channels which evidently are abnormal. The streams at Winsted are good illustrations of such changes.

Taken as a whole, the rivers of Connecticut have entrenched themselves in rocks which absorb but a small portion of the water that falls as rain, and accordingly the rivers carry to the sea a large part of the annual precipitation. A series of measurements made on the Connecticut from 1871 to 1885 shows a remarkable uniformity in the rainfall and in the per cent. of water which enters the river. The amount of annual run-off varied between 45 and 71 per cent., and the rainfall between 43 and 50 per cent., excluding the abnormally low rainfall of 1871. An examination of the monthly rainfall charts shows also a remarkable uniformity throughout the year, but there is considerable variation in the per cent. of run-off. The smallest amount of water is in the river in September. The per cent. of run-off in Connecticut rivers is very large and is in striking contrast to rivers of arid and semi-arid districts where a very small portion of the water which fall as rain is represented in the river. Because of the regularity in rainfall and the water-tight drainage basins certain brooks and streams in Connecticut that are not large

enough to be noticed in atlases carry more water to the sea during certain seasons of the year than great rivers like the Rio Grande and the Colorado River of Texas. A chart showing the discharge of the Housatonic River at Gaylordsville shows considerable variation, but there is enough water in the stream at all times to form a good river. The Rio Grande, on the other hand, varies between great abundance of water and stages when the valley of this large stream is dry.

There is no lack of water in Connecticut rivers, and as a supply for household purposes the river waters of the State are by nature entirely satisfactory. Increase in population and the development of manufactures have made the river waters of little value, but their loss of value is due to artificial conditions and does not depend upon geological structure of the State.

Lakes of Connecticut. One of the most marked features of the Connecticut landscape in the presence of lakes, ponds, and swamps. They owe their existence almost entirely to the fact that Connecticut has been overridden by a continental ice sheet. The land has been entirely remodeled, certain valleys have been filled, others scooped out. Materials of different characters have been widely and unevenly spread throughout the State, and the region, which perhaps before the Glacial age was thoroughly well drained, has now many places where the water remains for a considerable time before it is finally carried into the sea.

The great number of these lakes is manifest by the fact that on the topographic atlas of Connecticut there are mapped 1,026 lakes and 420 swamps. Lakes owe their permanency to the fact that evaporation is not so great as the supply of water, and wherever a lake occurs it is an indication that the water table or level of ground water stands permanently up to that height. In regions of slight rainfall the mineral particles in the water are concentrated, the lake becomes salt, and may entirely disappear by continued evaporation, leaving nothing but a plain of muds and sands carrying a high per cent of salts of different kinds. The lakes of Connecticut, however, are not in danger of extinction in this way. Their outlets may be cut down and the water thus drained, and they may be filled with sediment brought in by muddy tributaries, but most of them are doomed to extinction by the action of plant

life. Lakes, ponds, swamps, marshes, and bogs are members of one family just as are acorns, oak sprouts, oak trees, and oak stumps. They pass through a life history to ultimate extinction. Probably more than half of the water bodies which dotted the landscape in glacial time have disappeared, and many a Connecticut farmer is tilling choice bits of land which formerly were covered with lake water.

The lakes of Connecticut are a favorite source of water supply for cities, and nothing can be better. They are natural reservoirs and do not require the expense of constructing dams. The process of preparation for water supply is chiefly clearing out of undesirable vegetation and protection from pollution by outside agencies.

Ground Water in Connecticut. So far as they concern the ground water the geological formations of Connecticut consist of two very distinct parts, namely: the bed rock and the surface covering of loosened material. The bed rock of the State consists of sandstones, with their associated lava beds, in the center of the State, and the wide stretch of metamorphic and crystalline rocks which occupies the remainder of the State.

The crystallines consist of limestones, gniesses, and schists, with some granite and similar rocks locally developed. All of these rocks are of very great antiquity and show forms of structure which can be developed only at very great depths below the surface of the earth. They have been squeezed, and twisted, and injected with hot rock and hot water solutions, and have been so much altered that it is now next to impossible to determine the nature of these rocks before metamorphism took place. Their structure and present attitude indicate clearly that they are the bases of ancient mountain ranges, probably rivaling the Southern Appalachian in their height and ruggedness. All of these rocks have a common characteristic in that they are crystalline, that is, composed of crystals rather than broken grains or fragments. These crystals are placed tightly against each other and oftentimes interlocked so that there are no open spaces between them. The texture of the rock is so dense that there is no opportunity for water to circulate around the individual crystals. Such rocks are clearly not favorable as water-bearing beds. They contain some, but always a small amount of water, rarely over 1 per cent. A well sunk in such rock is apt to be a failure, or, at the most, furnish a scant sup-

ply. Rocks of this character are, however, oftentimes filled with joints and cracks which are not due to the original texture of the rock, but to the movements of the earth's crust which have taken place since the rock was formed. Under such circumstances crystalline rocks — granites, gneisses, and schists — contain a large amount of water, but it is not evenly distributed, and it is a chance that a particular well will be sunk in such a way as to take in the water occupying the crevices. Reports have come to me from places in this State where wells have been completely abandoned or used only during rainy seasons because they have been sunk in unjointed crystalline rocks. It is such rock that forms the beds of the upper tributaries of the Connecticut, and which enables that river to receive such a large share of the water which falls as rain.

The bed rock of the Connecticut Valley district, reaching from New Haven to Thompsonville, and extending from Mixville, Bristol, and North Granby on the west to Middletown, Glastonbury, and Hazardville on the east, is a sandstone of various grades of fineness, from clay-shales to conglomerates containing pebbles two or three feet in diameter. These rocks are made of grains more or less closely cemented together with iron, clay, and lime. There is considerable space about these grains, which may be occupied by water and, as a rule, each grain is surrounded by a film of water. Such rocks, therefore, are very favorable for water-bearing beds and may contain as much as 30 per cent. of their volume. Wells sunk in the sandstone in Connecticut yield abundantly, are rarely abandoned, and rarely do they need to be dug to great depths. In the list of wells in Connecticut, published in Bulletin No. 102, U. S. Geological Survey, it will be seen that a great number of the strongest flowing and most satisfactory wells and springs of the State are located in the sandstone belt.

The surface covering of rock in Connecticut is almost entirely of glacial origin. The soil formed during thousands of years of exposure to the atmosphere and water has been removed and carried to the south. If a hilltop in Connecticut is compared with one south of the glacial line a great difference will be noted. The southern peak shows rock fragments in all stages of decay, which have weathered from the mass underneath. They are part of the bed rock and have been de-

composed in place by the action of the atmosphere. The top of a Connecticut peak is seen to be rounded off and cut down to solid rock. No bowlders formed by decomposition occur on it. Formerly this peak resembled the one from Virginia. Another noticeable feature of the soil covering in Connecticut is the fact that loose materials lie directly upon solid polished rock beneath. There is no gradual change from loose soil to firm rock, but an abrupt transition. Furthermore, the soil is often composed of rock entirely different from that on which it rests. It has plainly been carried to its present position. South of the limit of glaciation there is a gradual transition from soil to unchanged rock.

This material deposited by the glacier is of two main classes, — the till or bowlder clay and the stratified drift.

Till is the material left by the glacier and came in part from that which was underneath the ice, and in part from the fragments at the side and on top of the ice. It is a jumbled mass, unstratified, and composed of materials of all sorts and of all sizes. It contains clay and small pebbles and large bowlders. The bowlders may be like the bed rock underneath and may have no relation to it. From the nature of the till it is evident that nothing like definite water-bearing beds can occur in it and that different parts of this mass can contain different amounts of water. Where the clays and sands are arranged in roughly parallel position the conditions are favorable for heavy water supply. Where the amount of clay is very large the conditions are not favorable. In general the till is of sufficient coarseness to contain a large amount of water, but it is difficult to predict the character of the water supply or its amount.

Where till layers rest directly on the rock, particularly on hill slopes, conditions are favorable for springs, and many springs and wet water seeps of this type are found throughout the State. Till occupies most of the highlands of Connecticut and is spread generally over the bed rock to a thickness varying from a few feet to over 100 feet. The till in valleys is generally underneath the stratified sands and gravels.

Stratified Drift is made up of materials deposited by glaciers, but the materials have been carried by water from the melting of the great ice sheet and distributed over the valleys

and lowlands, so that as the material is now found it has the appearance of water deposits rather than glacier deposits. Because of its method of deposition stratified drift is always in layers and the coarse material and fine material are separated from each other. Layers of coarse gravels and sands of different grades and classes are interbedded, and a section cut through the stratified drift shows ordinarily considerable variation in texture. These sands and gravels contain a large amount of pore space and water occupies them up to 30 or 40 per cent. of their volume. Sands are the great water-bearing beds and wells sunk in them below the level of the ground water are certain to have an adequate supply. However, the level of ground water in sand is liable to fluctuate more than that of boulder clay or bed rock, and it is advisable to sink wells to a depth somewhat below the water table. So great an amount of water is contained in stratified drift that it is the custom in Connecticut to sink a number of wells in close proximity to a considerable depth below the level of ground water and to use them as a single reservoir. For instance, on the New Haven plain the sands are saturated at a depth of less than 20 feet, and wells sunk to depths below that point have a supply of water in proportion to their depth. The gymnasium at Yale University is supplied by twenty of these wells driven closely together.

The water supply of Connecticut constitutes the mineral wealth of the State. Abandoned lands are being bought for summer homes and the essential condition of purchase is an adequate and satisfactory water supply from lake, spring, or well. Moreover, there are few farms in the State which would not give greater yields of hay and grain crops if the amount of available water were increased. I expect to see the day when irrigation is generally practiced in Connecticut. There is abundant water in rivers and lakes for the purpose; it needs only to be differently distributed. A careful detailed study of the water supply of the State and of the geological factors which control it would, I think, result in added wealth of crops and added value of the State as a summer resort.

OFFICIAL LIST OF AGRICULTURAL SOCIETIES HOLDING FAIRS IN 1905.

NAME OF SOCIETY.	PRESIDENT.	SECRETARY.	TREASURER.
New London County,	E. J. Miner,	T. W. Yerrington,	Chas. W. Hill,
Windham County,	Frank H. Deming,	J. B. Stetson,	Preston B. Sibley,
Rescon Valley,	Wm. J. Noble,	Wm. L. Lloyd,	W. G. Hard,
Berlin,	C. M. Jarvis,	W. W. Christian,	W. H. Upson,
Brantford,	Edwin Doolittle,	J. P. Callahan,	J. P. Callahan,
Colchester Grange,	J. R. Dutton,	M. R. Abell,	Isabel L. Strong,
Danbury,	S. H. Rundle,	G. M. Rundle,	John W. Bacon,
Farmington Valley,	O. F. Ferry,	E. A. Hough,	Benj. F. Case,
Granby,	Geo. O. Beach,	Theodore G. Chase,	Stanley W. Edwards,
Greenfield Hill Country Club,	N. H. Sherwood,	Mrs. D. B. Adams,	A. C. Acker,
Gulford,	A. Miner Leeds,	Robert DeF. Bristol,	Wm. C. White,
Harvinton,	Wm. J. Barber,	Lewis O. Catlin,	P. H. Hogan, Jr.,
Mad River Grange,	Arthur J. Pierpont,	Henry B. Cook,	W. LeRoy Garrigue,
New Haven Co. Hort. Society,	R. D. Fryde,	Thomas Pettit,	David Kydd,
New Milford,	F. LeRoy Buck,	J. E. Hungerford,	Edwin J. Emmons,
Newtown,	R. C. Mitchell,	P. H. McCarthy,	Henry G. Curtis,
Orange,	W. S. Woodruff,	A. D. Clark,	Edward L. Clark, Jr.,
Putnam Park Ass'n,	M. R. Joy,	E. M. Arnold,	Richard Gorman,
Rockville Fair Ass'n,	Andrew Kingsbury,	A. L. Martin,	F. A. Randall,
Stafford,	E. C. Dennis,	Geo. C. Eno,	Charles E. Curtis,
Stafford Springs,	E. C. Dennis,	W. L. Stiles,	Robert H. Fisk,
Suffield,	Waldo S. Knox,	C. F. Beckwith,	J. O. Haskins,
Union (Somers, etc.),	C. G. Arnold,	Henry D. Fletcher,	Chas. A. Thompson,
Waterbury Dripping Co.,	C. G. Camp,	N. W. Heater,	D. E. Cronin,
Woodstock Park Agri. Ass'n,	Chas. A. Gies,	T. R. Sudd,	Fred A. Sanderson,
Woodstock,	Charles E. May,	L. H. Healy,	Armin E. Brunn,
Conn. Dairymen's Association,	H. O. Daniels,	J. G. Schwink, Jr.,	B. C. Patterson,
Conn. Pom. Soc.,	J. C. Eddy,	H. C. C. Miles,	Orrin Gilbert.

RETURNS OF AGRICULTURAL SOCIETIES, 1905.—FINANCES.

SOCIETIES.	Cash on hand.	Single Admission Tickets.	Membership or Season Tickets.	Grand Stand.	Donations and Unclaimed Returns.	Rentance Fees, Trials or Speed.	Other Entrance Fees.	Rent of Grounds.	Other Sources.	State Appropriation, 1906.	TOTAL.
New London County,.....	\$67.77	\$716.80	\$165.00	\$704.25	.....	\$555.00	\$62.50	\$467.00	\$46.00	\$324.55	\$6087.87
Windham County,.....	.....	1105.95	18.00	162.55	\$15.00	37.50	101.50	284.00	107.15	244.07	2055.08
Beacon Valley,.....	61.05	878.15	63.00	47.50	55.00	175.50	41.25	175.00	22.10	186.45	1703.08
Berlin,.....	10.80	2717.35	302.00	203.25	588.50	85.00	.....	963.90	321.44	122.13	4600.78
Colchester Grange,.....	.....	68.50	.....	.....	17.10	.....	9.50	13.50	57.52	100.00	285.03
Farmington Valley,.....	26.60	919.60	.....	124.75	.....	300.00	77.75	202.50	544.14	144.97	2337.31
Granby,.....	43.55	685.15	.....	127.20	.....	397.50	.....	85.68	113.65	223.47	1593.56
Greenville Hill Country Club,.....	.....	903.17	153.25	375.50	331.70	.....	98.00	19.00	1703.85	133.87	3223.02
Hullford,.....	510.44	178.55	136.50	.....	6.00	.....	5.50	25.00	128.53	143.87	1845.19
Harwinton,.....	221.65	.....	.....	.....	.....	.....	28.95	357.30	72.90	136.58	960.75
Mad River Grange,.....	.....	489.55	.....	.....	14.50	.....	.....	8.00	227.63	155.07	1381.72
New River Co. Hort. Society,.....	240.90	881.25	50.00	.....	322.00	.....	.....	.....	112.50	151.07	1371.72
New Milford,.....	.....	880.70	.....	100.45	.....	547.50	.....	246.20	136.51	137.05	2346.03
Newtown,.....	1124.45	189.08	.....	314.30	100.00	431.50	5.00	319.00	136.71	181.94	3463.98
Orange,.....	1750.32	183.32	194.00	316.15	9.00	431.50	71.00	339.00	136.71	181.94	4960.96
Pittsford,.....	.....	1474.50	.....	531.00	.....	293.00	325.00	200.40	350.00	.....	3193.43
Rockville Fair Ass'n,.....	1158.55	262.10	132.00	663.50	.....	293.00	145.50	423.75	40.00	297.02	2769.14
Safford,.....	.....	885.10	.....	.....	50.00	265.00	.....	63.50	94.53	104.90	1149.53
Stafford Springs,.....	87.44	854.50	137.00	1205.50	.....	182.50	322.00	819.65	293.85	223.00	3830.30
Suffield,.....	97.94	1451.50	.....	118.40	.....	.....	630.00	168.75	193.80	100.00	3976.06
Union (Seneca, etc.),.....	927.51	.....	9.00	.....	3.00	.....	.....	31.00	163.25	193.10	1530.05
Woodstock Park Agri. Ass'n,.....	63.03	2424.55	75.00	504.00	.....	200.00	22.40	550.15	193.00	415.13	4413.55
Woodstock,.....	15.64	1015.95	53.00	233.65	63.00	114.00	66.60	247.50	196.67	224.30	2226.31
Conn. Dairyman's Ass'n,.....	723.45	.....	200.00	.....	.....	.....	.....	.....	.....	.....	2113.19
Conn. Pom. Soc.,.....	92.01	.....	493.00	.....	.....	.....	.....	.....	254.92	141.70	763.71

ANALYSIS OF PREMIUMS

GRATUITIES.—CONTINUED. FARM PRODUCTS AND MISCELLANEOUS.

[illegible]

AGRICULTURAL FAIRS IN CONNECTICUT.—1905.

SOCIETIES.	PLACE.	DATE.	ATTENDANCE.						Total.
			Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	
New London County.....	Norwich.....	Sept. 12-14.....	...	...	2,000	10,000	2,000	...	15,000
Windham County.....	Brooklyn.....	Sept. 12-14.....	...	100	2,000	1,500	...	...	2,600
Beacon Valley.....	Naugatuck.....	Sept. 4.....	...	...	5,000	...	...	...	5,000
Berlin.....	Berlin.....	Sept. 20-22.....	...	...	6,000	10,000	8,000	...	24,000
Colchester Grange.....	Colchester.....	Sept. 19.....	...	300	...	...	...	...	300
Farmington Valley.....	Collinsville.....	Sept. 6-7.....	...	...	900	2,000	...	...	2,800
Granby.....	Granby.....	Sept. 27-28.....	...	...	900	2,000	...	...	2,900
Greenfield Hill Country Club.....	Greenfield Hill.....	Sept. 12-15.....	...	...	1,897	4,376	1,908	...	8,091
Gulford.....	Gulford.....	Sept. 27.....	...	...	6,000	...	...	...	6,000
Harwinton.....	Harwinton.....	Oct. 3.....	...	15,000	...	...	...	...	15,000
Mad River Grange.....	Waterbury.....	Sept. 13-14.....	...	...	400	1,500	...	...	1,900
New Haven County Hort. Society.....	New Haven.....	Nov. 7-9.....	347	515	...	...	...	...	1,835
New Milford.....	New Milford.....	Sept. 12-15.....	...	20	1,000	2,000	700	...	3,730
Newtown.....	Newtown.....	Sept. 26-28.....	...	1,000	3,000	2,000	...	...	6,000
Orange.....	Orange.....	Sept. 4-5-6.....	...	2,500	1,500	...	...	...	4,000
Putnam Park Association.....	Putnam.....	Sept. 2-4-5.....	500	4,000	1,500	...	...	...	6,000
Rockville Fair Association.....	Rockville.....	Sept. 26-28.....	...	2,000	10,500	5,400	...	...	17,000
Simsbury.....	Simsbury.....	Oct.....	...	...	...	...	...	...	...
Stafford Springs.....	Stafford Springs.....	Oct. 3-4-5.....	...	2,000	12,000	6,000	...	...	20,000
Suffield.....	Suffield.....	Sept.....	...	1,200	3,800	...	...	...	5,000
Union (Somers, etc.).....	Broad Brook.....	Sept. 30.....	...	...	400	...	...	...	400
Horseshoe Park Agri. Asso.....	Willmantic.....	Sept. 12-21.....	...	500	7,000	2,000	...	...	9,500
Woodstock.....	So. Woodstock.....	Sept. 12-30.....	...	1,890	1,722	...	...	...	3,612
Conn. Dairymen's Asso.....	Hartford.....	Jan. 17-18, 1906.....	...	...	...	...	...	...	...
Conn. Pomological Society.....	Rockville.....	Sept. 26-28.....	...	...	...	...	...	...	...

OFFICIAL DIRECTORY

OF THE

CONNECTICUT PATRONS OF HUSBANDRY

FOR 1906.

OFFICERS OF CONNECTICUT STATE GRANGE.

Master, O. S. WOOD, Ellington.
 Overseer, B. A. PECK, Bristol.
 Lecturer, L. H. HEALY, N. Woodstock.
 Steward, F. P. JOHNSON, Warren.
 Assistant Steward, H. W. ANDREWS, Brookfield Center.
 Chaplain, REV. F. COUNTRYMAN, Stony Creek.
 Treasurer, N. S. PLATT, New Haven.
 Secretary, H. E. LOOMIS, Glastonbury.
 Gate-Keeper, E. F. HUTCHINSON, Andover.
 Ceres, MRS. NELLIE A. COOK, Hamden.
 Pomona, MRS. ADDIE C. HYDE, Brooklyn.
 Flora, MRS. HATTIE J. WELTON, Plymouth.
 Lady Steward, MRS. MAY K. TAYLOR, Lebanon.
 Annual Meeting the Second Tuesday in January.

EXECUTIVE COMMITTEE.

H. F. PORTER, North Haven, . . .	Term expires 1907
P. B. SIBLEY, Danielson, . . .	" " 1908
J. H. HALE, South Glastonbury, . . .	" " 1909
O. S. WOOD, <i>ex officio</i> , . . .	" " 1908
H. E. LOOMIS, <i>ex officio</i> , . . .	" " 1908

FINANCE COMMITTEE.

H. C. DUNHAM, Middletown.	J. H. BLAKEMAN, Oronoque.
G. A. HOPSON, East Wallingford.	

COMMITTEES FOR 1906.

WOMAN'S WORK.

MRS. MARY W. PHIPPS, Prospect.

DEPUTIES.

GEO. A. HOPSON, General Deputy, East Wallingford.
Central Pomona, No. 1, HUBERT S. BLAKE, New Britain.
Quinebaug Pomona, No. 2, C. H. POTTER, North Woodstock.
East Central Pomona, No. 3, ANDREW KINGSBURY, Rockville.
Mt. County Pomona, No. 4, J. H. PUTNAM, Litchfield.
New Haven County Pomona, No. 5, W. S. HINE, Derby.
New London County Pomona, No. 6, C. E. STAPLES, Colchester.
Excelsior Pomona, No. 7, F. M. CANDEE, Naugatuck.
Seaview Pomona, No. 8, E. H. WRIGHT, Clinton.
Fairfield County Pomona, No. 9, W. J. WOOD, Westport.
Hou't'ic Valley Pomona, No. 10, GILBERT A. VINCENT, Kent.

BOARD OF ARBITRATION.

The Executive Committee, Overseer, and Lecturer.

THE PATRONS' MUTUAL FIRE INSURANCE COMPANY.

President, GEO. AUSTIN BOWEN, Woodstock.

Vice-President, D. H. CARRIER, Glastonbury.

Treasurer, B. C. PATTERSON, Torrington.

Secretary, CHAS. E. BACON, Middletown.

Annual Meeting, Third Tuesday in February.

OFFICERS OF THE GRANGES.

NAME.	MASTER.	LECTURER.	SECRETARY.
POMONA GRANGES.			
Central Pomona, No. 1.	Henry C. Dunham, Middletown.	Mrs. B. B. Robbins, Bristol.	Chas. E. Bacon, Middletown.
Quinebaug Pomona, 2.	Everett E. Brown, Pomfret Center.	Jennie M. Robinson, Webster, Mass.	W. F. Day, Danielson.
East Central Pomona, 3.	Andrew Kingsbury, Rockville, R.F.D.	Mrs. Fannie L. Tilden, Ellington.	Mrs. Laura J. Brewer, Hockanum.
Mountain County Pomona, 4.	Geo. P. Douglass, Collinsville.	Miss E. Stockman, East Morris.	Arthur B. Ferry, Winsted.
New Haven Co. Pomona, 5.	Barnett J. Dickerman, Mt. Carmel.	Mrs. C. A. D. Allen, Wallingford.	Oscar L. Smith, North Haven.
New London Co. Pomona, 6.	Carroll E. Staples, Colchester.	F. N. Taylor, Lebanon.	O. L. Pultz, Lebanon.
Seaview Pomona, 7.	Wilson L. Pierpont, Waterbury.	Lewis Garrigue, Waterbury.	Mrs. Martha E. Judd, Southbury.
Scarliver Pomona, 8.	A. D. W. Chalker, Saybrook.	Myron G. Skinner, Higganum.	D. Eugene Smith, Madison.
Fairfield County Pomona, 9.	Joseph Adams, Westport.	Mrs. D. A. St. John, New Canaan.	Mrs. F. E. Blakeman, Oronoque.
Housatonic Valley Pomona, 10.	H. W. Treat, Bridgewater.	G. H. Smith, Kent.	F. S. Peet, Kent.
SUBORDINATE GRANGES.			
Washington, No. 11.	Ralph J. Averill, Wash. Depot.	Mrs. Anna Clark, Wash. Depot.	Frederick J. Ford, Wash. Depot.
Tuxia, 12.	F. L. Granger, Jr., Bloomfield.	Mrs. Geo. K. Marvin, Bloomfield.	Geo. K. Marvin, Bloomfield.
Hope, 13.	Eugene Wadhams, Torrington.	Mrs. Mary French, Torrington.	K. K. Kimberly, Torrington.
Lebanon, 14.	Otto L. Pultz, Lebanon.	Mrs. Hortense E. Pultz, Lebanon.	F. N. Taylor, Lebanon.
Cheshire, 15.	Willis B. French, Cheshire.	Frederick Doolittle, Cheshire.	S. A. Buckingham, West Cheshire.
Berlin, 16.	Earl Cooley, Berlin.	Mrs. Walter L. Atwater, Berlin.	W. H. Shumway, Berlin.
Union, 17.	D. H. Bennett, Plantville.	M. M. Friebe, Southington.	James W. Upson, Marlon.
Glastonbury, 18.	Stancliff Hale, South Glastonbury.	William H. Carrier, Glastonbury.	Miss Lucy E. Miller, So. Glastonbury.
Suffield, 19.	Julius I. Ives, South Meriden.	John S. Gardner, Suffield.	Ralph E. Moody, Suffield.
Meriden, 20.	Edwin F. Newton, Agawam, Mass.	Mrs. Mary A. Ives, South Meriden.	Mrs. Mabel A. Francis, Wallingford.
Wapping, 21.	Arthur E. Loomis, S. Manchester.	Miss Emily M. Lane, Rockville.	Miss S. Rosa Dewey, Buckland.
Manchester, 22.	Mrs. A. T. P. Brush, W. Cornwall.	Miss Mabel J. Loomis, S. Manchester.	Keeney B. Loomis, South Manchester.
North Cornwall, 23.	Franklin Hill, Wallingford.	Noah Rogers, W. Cornwall.	Mrs. Nies Scoville, West Cornwall.
Wallingford, 24.	John Crowley, Canton.	Mrs. Jennie Hough, Yalesville.	Flora E. Hough, Wallingford.
Canaan, 25.	Hobart J. Brackett, Clintonville.	Mrs. Sarah Johnson, Collinsville.	Mrs. Annette E. Case, Canton.
North Haven, 26.	Austin E. Pearle, Hampton.	Mrs. E. F. Potter, North Haven.	Myron R. Brackett, North Haven.
Little River, 27.	Archibald Evans, Hockanum.	Mrs. Mary Litchfield, Hampton.	Mrs. Angie M. Burnham, Hampton.
East Hartford, 28.	J. Howard Hoyt, New Canaan.	Charles R. Risley, Silver Lane.	Miss Charlotte C. Smart, Silver Lane.
New Canaan, 29.	Chas. T. Lindeman, Putnam.	Frank N. Horton, New Canaan.	William C. Durban, Darien.
Burrill, 30.	J. B. Bilven, New London.	Miss Lila Clark, New Britain.	Mrs. F. H. Sharpe, New Britain.
Kononoc, 31.	Richard Atkins, Middletown.	Joseph Spaulding, Woodstock.	Chauncey S. Child, Woodstock.
Mattabesett, 32.	Leroy E. Pearle, Brooklyn.	Mrs. J. B. Bilven, New London.	A. E. Bilven, New London.
Brooklyn, 33.	Charles L. Luce, New Britain.	Mrs. Jennie Birdsey, Middletown.	Mrs. Fannie W. Prior, Middletown.
Newington, 34.		Fred Page, Wauregan.	Miss Gladys Stone, Brooklyn.
		Howard E. Dabney, Newington.	Mrs. Nellie L. Eddy, New Britain.

OFFICERS OF THE GRANGES. — CONTINUED.

NAME.	MASTER.	LECTURER.	SECRETARY.
SUBORDINATE GRANGES — Cont.			
45. Ellington,	Harrison L. Hamilton, Ellington,	Mrs. Emily Parsons, Ellington,	James M. Marks, Ellington.
46. Bolton,	C. N. Loomis, Jr., Manchester,	Miss Adelia N. Loomis, Bolton,	Miss Maude E. White, Bolton.
47. Whylville,	A. D. Carnell, Forestville,	Mrs. Ida Lowrey, Bristol,	Robert Carnell, Forestville.
48. Wadfield,	Edward A. Smith, Middletown,	Charles Congdon, Middletown,	Mrs. Mary Addis, Middletown.
50. Tolland,	C. Hubbard West, Rockville,	Mrs. S. E. Edgerton, W. Willington,	Mrs. Edythe N. Edgerton, W. Willington.
51. Vernon,	Charles W. Bradley, Rockville,	Mrs. Geo. Webster, Plainville,	Mrs. Emma D. Plakin, Talcottville.
52. Plainville,	Henry Tyler, Plainville,	Mrs. Louise Ryder, Plainville,	Mrs. W. H. Plummer, Forestville.
53. Stafford,	I. P. Booth, Stafford,	J. M. Larned, Stafford Springs,	Mrs. Abbie Ide, Stafford.
54. East Haddam,	Robert W. Bingham, Little Haddam,	Edwin W. Crocker, Moodus,	S. E. Williams, Colchester.
55. Durham,	C. W. Coe, Northford,	W. L. Davis, Durham Center,	W. L. Davis, Durham Center.
56. West Hartford,	A. B. Alderson, West Hartford,	L. W. Harvey, West Hartford,	Edwin H. Munger, West Hartford.
57. Saybrook,	Geo. E. Sheffield, Saybrook,	Mrs. Mary S. Clark, Saybrook,	Mrs. Marion A. Chalker, Saybrook.
58. Crystal Lake,	Ward G. Holman, Eastford,	Miss Alice J. Carpenter, Eastford,	Mrs. L. A. Keith, Eastford.
59. Wolf Den,	Everett E. Brown, Pomfret Center,	Mrs. Alice E. Wilbur, Abington,	Mrs. Anna L. Badger, Abington.
60. Eureka,	G. C. Beckwith, Nepaug,	G. F. Goodenough, Torrington,	H. G. Douglas, Collinsville.
61. Middlefield,	Almon D. Emmons, Middlefield,	Miss Lucina C. Miller, Middlefield,	Mrs. Clara E. Goodrich, Middlefield.
62. Mansfield,	H. L. Garrigus, Storrs,	H. D. Edmund, Storrs,	W. A. Stocking, Jr., Storrs.
63. Quinnsisset,	Henry M. Thomson, Thompson,	Mrs. Alice Elliott, Thompson,	Calvin Ballard, Thompson.
64. Killingworth,	Burton G. Waugh, Higganum,	Geo. S. Butler, Cromwell,	Mrs. Hattie M. Davis, Clinton.
65. Cromwell,	Ira M. Barrows, Cromwell,	Helen A. Litchfield, Chaplin,	Miss Lottie M. Sage, Cromwell.
66. Natchaug,	Burton M. Welch, Chaplin,	Mrs. Eva Kimball, Hampton,	Clarence E. Chester, Chaplin.
67. Canterbury,	Jarred Fuller, Scotland,	Mrs. Grace I. Barrows, S. Canterbury,	Leon J. Moditt, Hampton.
68. Mad River,	Lemuel N. Carpenter, Canterbury,	Mrs. Jeanie S. Judd, Waterbury,	Levi N. Clark, So. Canterbury.
69. Plymouth,	Arthur J. Pierpont, Waterbury,	Harry D. Emmons, Plymouth,	Mrs. Anna Hall Pierpont, Waterbury.
70. Indian River,	Herbert W. Cleaveland, Plymouth,	Albert N. Beard, Milford,	Edith E. Sutcliffe, Plymouth.
71. Winchester,	Fred M. Smith, Milford,	Hopson H. Hurd, Milford,	Geo. S. Clark, Milford.
72. Coventry,	Chas. E. Johnson, Norfolk,	John E. Kingsbury, Rockville,	Edward L. Humphrey, Winsted.
73. Andover,	Oliver C. Hall, Coventry,	Mrs. Anna E. Phelps, Andover,	Andrew Kingsbury, Rockville.
74. Clinton,	Dwight A. Clark, Andover,	Mrs. Sarah E. Bronson, Clinton,	Mrs. Emma C. Clark, Andover.
75. Colchester,	Solden S. Carter, Clinton,	Mrs. Ida Wagner, Colchester,	William H. Kelsey, 2d, Clinton.
76. Housatonic,	Carroll E. Stapl s, Colchester,	R. O. Spamer, Oroonoke,	Mrs. Hattie J. Strong, Colchester.
77. Colebrook,	Harry Wilcoxson, Stratford,	Miss Grace I. Allen, Winsted,	Geo. Meachen, Stratford.
78. Foxon,	Geo. H. Mills, Winsted,	Franklin Countryman, N. Branford,	Mrs. S. Ellen Northrop, Colebrook.
79. Waumbang,	Andrew J. Granniss, New Haven,	Mrs. Florence Trask, So. Coventry,	F. M. Sperry, East Haven.
80. Webstock,	Frank A. Spaulding, So. Coventry,	Mrs. F. R. Rundall, Amenla Union, N.Y.,	Helen M. Potter, Willimantic.
81. Hilltown,	J. S. Chaffee, Amenla Union, N.Y.,	Hattie E. Brewer, Hockanum,	H. V. D. Reed, Amenla Union, N.Y.
	Chas. G. Strickland, So. Manchester,		Laura J. Brewer, Hockanum.

OFFICERS OF THE GRANGES.—CONTINUED.

NAME.	MASTER.	LECTURER.	SECRETARY.
SUBORDINATE GRANGES.—Cont.			
Ekonk, 89.	E. Byron Gallup, Ekonk.	Mary E. Gallup, Ekonk.	Miss Esther G. Gallup, Ekonk.
Seymour, 91.	E. J. Leavenworth, Seymour.	Miss May R. Holbrook, Seymour.	Miss Mary A. Hall, Seymour.
Harmony, 92.	Homer E. Clarke, Stepney Depot.	Miss Ethel J. Wales, Stepney Depot.	Edwin C. Shelton, Stepney Depot.
Border, 93.	Chas. E. Little, Williamantic.	Mrs. Louise A. Goss, Williamantic.	Mrs. Lillian M. French, Williamantic.
East Windsor, 94.	W. W. Thompson, Warehouse Pt.	Dr. H. O. Allen, Broad Brook.	Mrs. K. E. Sloughion, Warehouse Pt.
Jewett City, 95.	Henry W. Morse, Jewett City.	Ervin L. Barnes, Norwich.	William R. Palmer, Jewett City.
Hamden, 96.	Oscar L. Smith, North Haven.	Mrs. Catherine Beecher, Hamden.	Thomas Dunn, Mt. Carmel.
Taghannuck, 100.	Mrs. A. C. Buckley, Amenia, N. Y.	Mrs. C. L. Palmer, Sharon.	Mrs. Ella B. St. John, Sharon.
Madhapung Lake, 101.	Levi M. Reed, Stafford Springs.	Mrs. Nancy E. Howard, Stafford Spr'gs.	H. R. Howard, Stafford Springs.
Beacon Valley, 103.	F. M. Candee, Naugatuck.	Belle F. Fowler, Naugatuck.	R. C. Fowler, Naugatuck.
Somers, 105.	S. Dwight Percival, Somers.	C. J. Stephenson, Somers.	Miss Ida Ray Kibbe, Somers.
Litchfield, 107.	F. B. Plumb, Litchfield.	J. H. Putnam, Litchfield.	Ida E. Plumb, Litchfield.
Woodbridge, 108.	Arthur H. Doolittle, Bethany.	Chas. A. Bond, Westville.	Leroy C. Beecher, Westville.
East Hampton, 109.	Otis Goff, East Hampton.	Mrs. Ola West, East Hampton.	Herbert F. Brown, Norwich.
Preston City, 110.	Nathan H. Hall, Norwich.	Allen B. Burdick, Norwich.	Mrs. Flora E. Buell, Gilead.
Hebron, 111.	Henry A. Spaford, Turnerville.	Arthur E. Hutchinson, Gilead.	C. Ella Day, Danielson.
Killingly, 112.	F. B. Sibbey, Danielson.	Ray Pelet, Danielson.	Mrs. Fred A. Sanderson, Moosup.
Highland, 113.	Jason J. Martin, So. Killingly.	Mrs. Emma Vaughn, So. Killingly.	Dudley Wells, So. Westfield.
Wethersfield, 114.	Franklin G. Welles, Wethersfield.	Miss Catherine Smith, Wethersfield.	Fred L. Belden, Rocky Hill.
Rocky Hill, 115.	Everett E. Wright, Rocky Hill.	Mrs. Edna Burton, Rocky Hill.	Mrs. Mary C. Perkins, Bristol.
Bristol, 116.	Robert W. Gayford, Bristol.	Chas. F. Olin, Bristol.	Mrs. Flora M. Dodge, Deep River.
Unity, 117.	Ellsworth A. Lynde, Deep River.	Frederick L. Himmelden, Deep River.	Miss Lona L. Peck, Norfield.
Beacon, 118.	E. A. Hopkins, Thomaston.	Chas. Halline, Thomaston.	Shas. E. Stockman, East Morris.
Morris, 119.	Wm. F. Kirchberger, Thomaston.	Miss Gertrude Barthel, Thomaston.	Geo. W. Peck, Bethel.
Bethlehem, 121.	James W. Flynn, Bethlehem.	Mrs. Carrie Hill, Bethlehem.	James A. Black, Westtown.
Watertown, 122.	Orrin D. Ealey, Watertown.	Mrs. O. D. Ealey, Watertown.	David C. Dibble, Westbrook.
Westbrook, 123.	Orance B. Kelsey, Westbrook.	Mrs. Alice E. Edson, Westbrook.	Frederic O. Barr, Higganum.
Higganum, 124.	August B. Carlson, Higganum.	Frederic Kelsey, Higganum.	Mrs. I. Ganser, Higganum.
Holbrook, 125.	Allen I. Blodgett, Falls Village.	Chas. W. M. Cull, Falls Village.	Mattie E. Barnes, Woodbury.
Pleasant Valley, 126.	Arthur N. Shelton, Woodbury.	Michael F. Shelton, Woodbury.	Harold E. Waldo, Naubuc.
Greenville, 127.	Alfred E. Hollister, Glastonbury.	Mrs. Rose E. Goodale, Glastonbury.	Irving A. Andrew, Orange.
Orange, 128.	A. S. Crosby, Orange.	Mrs. W. S. Hines, Derby.	Mrs. Hattie M. Northrop, Newtown.
Poultney, 129.	John J. Northrop, Newtown.	Allison P. Smith, Newtown.	Miss Eleanor L. Wooster, Shelton.
Farmville, 130.	John J. Northrop, Newtown.	Miss Daisy Card, Shelton.	Amelia J. Fuller, Cornwall Bridge.
Columbia, 131.	Joseph N. Clarke, Columbia.	Fred'k P. Johnson, Cornwall Bridge.	Chas. F. Perkins, Cornwall Bridge.
Wichita, 132.	Wm. C. Welton, Cornwall Bridge.	W. Sanford Jennings, Fairfield.	D. Frank Brown, Fairfield.
Greenfield Hill, 133.	Simson Pease, Fairfield.		

OFFICERS OF THE GRANGES. — CONCLUDED.

NAME.	MASTER.	LECTURER.	SECRETARY.
SUBORDINATE GRANGES. —			
Trumbull, 134.	H. S. Beach, Trumbull,	Mrs. H. S. Beach, Trumbull,	E. T. Nichols, Bridgeport.
Silver Lake, 135.	Geo. B. Hamlin, Sharon,	Miss Emmeline Palmer, Sharon,	Miss E. D. Scott, Sharon Valley.
East Canaan, 136.	W. W. Howland, East Canaan,	Miss Clara Bortum, East Canaan,	Mrs. Minnie Howland, East Canaan.
Middlebury, 137.	Arthur F. Greene, Woodbury,	Miss Addie J. Fenn, Waterbury,	Mrs. Martha E. Judd, Southbury.
Plainfield, 138.	Turner E. Greene, Plainfield,	J. Naude Olin, Plainfield,	A. H. Mathewson, Plainfield.
Brookfield, 141.	Clarence B. Hawley, Hawleyville,	Lillian Blackman, Brookfield Center,	Juliette W. Sagendorf, Brookfield C.
Rock Rimmon, 142.	O. D. Buckingham, Beacon Falls,	Mrs. Hortense Rice, Beacon Falls,	Mrs. Jennie Burton, Beacon Falls.
Goshen, 143.	Karni Kimberly, Goshen,	Miss Heppie Miles, Goshen,	Dr. J. H. North, Goshen.
Prospect, 144.	Charles S. Fenn, Prospect,	Mrs. Bennett, Stamford,	Mrs. Sara S. Talmadge, Waterbury.
Rippowam, 145.	Cyrus Saries, Springdale,	Mrs. Carrie L. Bradley, Westport,	Mrs. Mable W. Crissey, Stamford.
Norfield, 146.	Iverson C. Fenton, Westport,	Mrs. Lizzie Bill, Lyme,	Arthur C. Bradley, Westport.
Lyme, 147.	William Marvin, Hamburg,	Mrs. Geo. W. Guyer, Westport,	Mrs. Mary R. Fiedick, North Lyme.
Easton, 148.	Wm. J. Wood, Westport,	Mrs. Florence Candee, Bridgeport,	H. B. Fairchild, Westport.
Woodstock, 149.	Jesse H. Wheeler, Bridgeport,	Chas. H. Potter, Southbridge,	W. S. Gillette, Long Hill.
Enfield, 150.	Chas. H. Kilham, Southbridge,	Mrs. Emily R. Northrop, Bridgeport,	Leonard H. Healey, N. Woodstock.
Canon, 151.	Harry J. Bridge, Hazardville,	Miss Sadie Sturges, Cannon,	Sophia L. Gopley, Hazardville.
Bridgewater, 152.	Albert B. Mallett, Bridgewater,	Mrs. Amy R. Pease, Thompsonville,	Nelson H. Hurlbutt, Cannon.
Kent, 153.	Gilbert A. Vincent, Kent,	Mrs. Emily R. Northrop, Bridgeport,	Willis K. Frost, Bridgewater.
Danbury, 154.	A. B. Brundage, Danbury,	Geo. H. Smith, Kent, Danbury,	Miss Mildred S. Page, Kent.
East Lyme, 155.	Fredrick O. Erney, East Lyme,	Mrs. Eunice R. W. Wood, Chester,	Chas. H. Brundage, Danbury.
Chester, 156.	Geo. W. Cox, Chester,	Mrs. George T. W. Wood, Chester,	Silas J. Weaver, East Lyme.
Salisbury, 157.	Chas. S. Phelps, Chapinville,	Mrs. C. S. Phelps, Chapinville,	Chas. R. Wooster, Chester.
Aspenuck Valley, 158.	Sheldon E. Hendrick, New Milford,	Mrs. C. Ellis A. Kinn, New Milford,	James R. Harrison, Salisbury.
Bogran, 159.	E. Judson Miner, Fitchville,	Mrs. Mabel A. Kinn, New Milford,	Daniel Marsh, New Milford.
Old Lyme, 160.	Engrue D. Caulking, Old Lyme,	Joseph S. Huntington, Old Lyme,	Charles J. Johnson, Fitchville.
Redding, 161.	Albert A. Gorham, Redding,	Mrs. E. V. Bradley, Redding Ridge,	Wither F. Sebley, Old Lyme.
			Mrs. F. O. Sanford, Redding Ridge.

REPORT OF THE TREASURER.

CHAS. A. THOMPSON *in account with*

STATE BOARD OF AGRICULTURE

	1904		Dr.	Cr.
July 1.	Balance amount in treasury,	.	\$3,293.80	
" 16.	D. W. Patten,	.		\$19.60
Aug. 11.	Case, Lockwood & Brainard Co.,	.		120.95
Nov. 10.	L. A. Clinton,	.		61.00
" "	B. C. Patterson,	.		129.79
Dec. 16.	Sedgwick & Casey,	.		5.00
" "	Allyn House,	.		251.75
" "	F. H. Stiles,	.		75.00
" "	M. F. Delano,	.		40.50
" "	Martha Van Rensselaer,	.		50.00
" "	For railroad fares of delegates,	.		125.00
" "	New Dom,	.		34.00
" 20.	Wm. H. Honiss,	.		90.00
" "	James B. Palmer,	.		129.50
" "	L. B. Harris,	.		29.94
" 28.	Herbert E. Gregory,	.		25.00
1905.				
Jan. 3.	I. C. Fanton,	.		20.75
" "	E. G. Seeley,	.		78.09
" "	C. A. Thompson,	.		43.62
" "	Edmund Halladay,	.		29.25
" "	Seaman Mead,	.		30.92
" "	Charles E. Chapman,	.		29.10
" 7.	N. S. Platt,	.		8.88
" "	N. G. Williams,	.		13.74
" "	Case, Lockwood & Brainard Co.,	.		97.20
" "	J. E. Wing,	.		77.00
" 5.	One-half State appropriation,	.	\$1,750.00	
" 7.	H. I. Spalding,	.		20.00
" "	W. F. Andross,	.		25.00
" "	D. W. Patten,	.		15.25
Feb. 2.	James F. Brown,	.		644.02

1906.]

REPORT OF THE TREASURER.

313

Feb. 2.	L. A. Clinton,	.	.	.	.	\$33.01
" "	John Coombs,	.	.	.	.	15.00
Mar. 25.	L. A. Clinton,	.	.	.	.	5.00
Apr. 26.	Will H. Barron, Jr.,	.	.	.	.	5.78
" "	Burroughs & Hopkins Co.,	.	.	.	.	4.74
May 1.	Edmund Halladay,	.	.	.	.	33.25
" "	L. A. Clinton,	.	.	.	.	15.13
" "	A. D. Shamel,	.	.	.	.	38.77
" "	R. W. Simpson,	.	.	.	.	5.26
June 6.	Charles F. Roberts,	.	.	.	.	80.10
" "	C. L. Beach,	.	.	.	.	11.78
" "	C. A. Thompson,	.	.	.	.	9.49
" 20.	Cooper Curtis,	.	.	.	.	15.50
" 29.	F. A. Holden,	.	.	.	.	1.65
" "	By one-half State appropriation,	.	.	.	\$1,750.00	
July 1.	J. C. Fanton,	.	.	.	.	45.60
" "	I. C. Fanton,	.	.	.	.	34.55
" "	Charles E. Chapman,	.	.	.	.	34.60
" "	N. G. Williams,	.	.	.	.	21.17
" "	Charles A. Thompson,	.	.	.	.	58.35
" "	James F. Brown,	.	.	.	.	661.07
" "	Edmund Halladay,	.	.	.	.	35.30
" "	James B. Palmer,	.	.	.	.	26.57
" "	E. G. Seeley,	.	.	.	.	21.50
" "	Seaman Mead,	.	.	.	.	5.30
" "	Case, Lockwood & Brainard Co.,	.	.	.	.	63.10
" "	Balance amount in treasury,	.	.	.	.	3,192.38
						\$6,793.80 \$6,793.80

This is to certify that we have examined the accounts of the Treasurer of the State Board of Agriculture and found them correct.

SEAMAN MEAD,	} Auditors.
D. W. PATTEN,	
CHAS. E. CHAPMAN,	

July 1, 1905.



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State of Connecticut.
PUBLIC DOCUMENT No. 32.

FIFTEENTH REPORT

OF THE

DAIRY COMMISSIONER,

MADE TO THE GOVERNOR,

A. D. 1905,

FOR THE

YEAR ENDING SEPTEMBER 30, 1905.

ORDERED PRINTED BY THE LEGISLATURE.

**TORRINGTON, CONN. :
THE TORRINGTON PRINTING COMPANY,
1905.**

**PUBLICATION
APPROVED BY
THE BOARD ON CONTROL.**

State of Connecticut
DAIRY COMMISSIONER'S OFFICE

Room 54, Capitol, Hartford.

TELEPHONE CALL, 1651.

JOHN B. NOBLE,
Commissioner.

ROBERT O. EATON,
Deputy Commissioner.

MISS HELEN F. POND,
Clerk and Stenographer.



To His Excellency, Henry Roberts, Governor of the State of Connecticut:

Sir: In accordance with the provisions of the General Statutes I herewith have the honor to submit my report for this department for the fiscal year ending September 30th, 1905.

Respectfully,

JOHN B. NOBLE,
Dairy Commissioner.

REPORT.

The work of this department during the year covered by this report has been, in the main, satisfactory and productive of good results. We have made thorough and systematic investigation all over the State and during the year the work has at no time been relaxed. On the contrary, we have endeavored, at all times to carry out to the best of our ability all the provisions of our pure food laws.

We have been very much gratified to learn that the efforts of this department are sustained and upheld by the public in general and by the press more than ever before.

Food being necessary to sustain life; it is necessary that it should always be free from harmful ingredients. And, in case harmless adulterants are used, the article should be plainly label-

led so that there could be no deception; and so that consumers could know, at all times, just what they are purchasing. These are necessary as regards health and from a financial standpoint.

OLEOMARGARINE.

The manufacture and sale of oleomargarine in the United States has decreased very largely since the passage of the so-called Grover Bill in 1902, which requires a tax of 10c on all colored oleomargarine and ½c on all uncolored.

There is no colored oleomargarine sold in Connecticut, at the present time. The uncolored is used to some extent. This may be sold and used according to the provisions of our law, which requires that signs be displayed in stores, bakeries, restaurants, hotels or wherever used or sold.

We have made a careful inspection of all places where it is used or supposed to be used and always insist on this provision of the law being carried out.

There have been efforts put forth at every Congress, since the passage of this law to secure its repeal but it has been so clearly shown that there was always a constant effort on the part of manufacturers and dealers throughout the country to sell this product for genuine creamery butter to the great detriment of all dairymen and consumers in general that these efforts have proved futile.

The law is now safely fixed and we think no effort can secure its repeal. We have fifteen licensed oleomargarine dealers in the state. One is a large wholesaler. There has been a great deal of ingenuity displayed by oleomargarine manufacturers to cause their product to look like yellow butter and still not be liable under the law. Most of these devices have failed. They use quite a percentage of pure creamery butter in its manufacture and this is allowable if the butter has not been artificially colored. This helps to give the product a slightly yellow cast.

We have examined, during the year, over fifteen hundred grocery stores and some of them several times. In this inspection

we have examined all of the butter sold in order to see if there were any oleomargarine on the market and also to see if there was any

RENOVATED BUTTER

kept for sale; and if the provisions of our renovated butter law were being complied with in regard to stamping.

There is quite a large quantity of renovated butter sold. Much of this is a very good product and it is a legitimate product of food if sold for what it is.

The National law requires that all print renovated butter must be stamped with the words "Renovated Butter" on the print and also the wrapper. Tub Renovated must be stamped on the tub and on the top of the butter in the tub. But when these tubs are put into the dealers' cases and the words "Renovated Butter" are removed from the top of the butter in the tub, there is no means by which the consumer may know what the butter is. Our law requires that all this butter shall be stamped with the words "Renovated Butter" on the wrapper in printed letters not less than one-half inch in length, of plain Gothic style. Notices have been sent to all dealers that the provisions of this law must be complied with.

Examinations of the different stores show that most dealers are complying with this law, having their paper stamped, or printed, as required by law.

Occasionally we have found some dealers who through ignorance or for other reasons have neglected to do this. If this is continued after our examination, prosecution follows.

It is not right that renovated butter should come in competition with pure dairy or creamery butter, without the purchasers' knowledge. It is a legitimate article of trade but it must be sold for what it is.

VINEGAR.

The law regulating the manufacture and sale of vinegar is important because it interests all those who are manufacturing a

pure cider vinegar, and also it is unjust to all consumers who wish a pure cider vinegar to receive a cheaper article made from acid, etc.

In our investigations through the state we find that the provision of our law requiring that the cask shall bear the vinegar maker's name and address is not always complied with. Dealers purchasing vinegar should look very carefully to this and see that the cask is properly stamped or labelled. Some dealers purchase a cheap, manufactured compound, and then sell it for pure cider vinegar to the unsuspecting consumers. In several cases we have found Malt vinegar sold as Cider vinegar.

The department has been obliged to bring several prosecutions under this law. The same principal applies to vinegar as to other food products—they must be sold for what they are and no articles injurious to health must be employed in their manufacture.

Malt vinegar, Acid vinegar, etc., must not be sold as a Cider vinegar. All who do this, do so at their own risk and are liable to prosecution.

LARD.

The sale of lard, in this State, is quite large—both pure and compound.

Compound lard, which is usually a mixture of lard and cotton seed oil is a legitimate article of trade but it must be sold as "Compound Lard."

We have had quite a number of prosecutions during the year for dealers who were selling this compound lard as pure lard.

Compound lard is stamped on the package containing it, with the word "Compound" but the consumer does not see this, and so, many times, gets a cheap mixture of lard and cotton seed oil when they suppose they are purchasing pure lard.

One party advertised in his store window "Pure Leaf Lard, 10c per lb." Some of this was purchased and was found to contain a large percentage of cotton seed oil. The dealer was prosecuted and paid his fine.

We insist that compound lard shall be sold for just what it is, and that consumers must not be imposed upon, or deceived.

LABELLING.

The correct labelling of all food products is a matter of great importance in the enforcement of all pure food laws, and is a requirement insisted upon at all times by this department.

Many articles are so labelled as to be very misleading. In the case of flavoring extracts, the label on the bottle sometimes shows that there are ingredients, the names of which do not appear on the carton. As very few people, when purchasing an extract, look at the bottle, we believe that it is right and just that the carton should be labelled so as to correctly inform the purchaser the composition of the article. The same applies to all articles put up in cartons.

Some of the flavoring extracts have also been found to be very deficient in oil, so that they were of little strength. One New York house criticised the result of our analysis very strongly regarding their lemon extract. We insisted that our analysis as taken by our chemist was correct and that their lemon extract was very deficient in lemon oil. This firm had another examination made in New York after which they wrote me that the Connecticut chemist was right and that in the future another method would be adopted by them for extracting the oil and making their extract; and they would send only such extracts as were of good quality to Connecticut.

COFFEE, PEPPER AND SPICES.

Quite a number of the samples of the above food products, analyzed at the Experiment Station have been found to be badly adulterated. Returns to this department, from the station, show that there has been quite an improvement in the coffee on the market from what it was a few years ago but there is still considerable ground coffee sold in bulk and otherwise, adulterated to

quite an extent. Adulterants used are cereal products, peas and chicory.

A good many cases of adulterated pepper have been found. Wheat products, ground coffee hulls, olive stones and maize products have been found mixed with pepper; and cayenne has been found artificially colored.

When our notice was sent to the retail dealers, regarding these adulterations, one wholesale house in particular was notified by the retailer. They insisted that there must be some mistake for they bought their pepper ground from a New York house which sold them only pure goods. We took samples from the said wholesale house of this same pepper, had one of the firm examine it under the microscope with the chemist at the Experiment Station. After this examination, he was perfectly satisfied that there was a very large percentage of foreign products.

Mustard has been found to be adulterated largely with wheat flour and tumeric, wheat flour being used as the adulterant and tumeric for a coloring matter. This cheapens the article very materially and is a direct fraud on the consumer.

OLIVE OIL.

This has, in several cases, been found to contain quite a percentage of cotton seed oil.

Dealers must understand that where they sell an article like this adulterated with some substitute which is not injurious to health they must label it so as to plainly state of what it is composed.

PRESERVATIVES.

One of the worst forms of violation of our pure food laws is the use of preservatives or antiseptics.

One section of our law states, "That an article shall be deemed adulterated if it contains poisonous ingredients which shall render such article injurious to the health of the party consuming it; or if it contains any antiseptic or preservative not evident, and not known to the purchaser or consumer."

We have, in connection with the Experiment Station, taken quite a number of examinations in this line during the year; and in the coming year we are to cover a still broader field, taking in more food products in our examination—and in our endeavor to stop the use of these antiseptics and preservatives or have the food product labelled.

We find boric acid, or borax is used quite extensively in various kinds of food products. The question as to whether these articles are injurious to health has often been raised. On this point we take the liberty to refer to the statements of H. W. Wiley, Chief of the Bureau of Chemistry in the Department of Agriculture at Washington.

In his report to the Hon. James Wilson, Sec'y of Agriculture, he states, "When boric acid or its equivalent in borax is taken in food, in small quantities—not exceeding half a gram a day—no notable effect is immediately produced. In cases of long continued use of small doses, or larger doses for a shorter period, medical symptoms show, in many cases, a manifest tendency to diminish the appetite and produce a fullness and uneasiness in the stomach, which in some cases results in nausea. A sense of fullness in the head, which is often manifested in a dull and persistent headache; and in some instances sharp and well located pain. Where boric acid is used to the amount of four or five grams per day, it results in most cases in loss of appetite and inability to perform any kind of work."

Dr. Wiley also states that of course it is not to be denied that both borax and boric acid are recognized as valuable remedies in medicine; but the fact that any remedy is useful in medicine does not appear to logically warrant its use at any other time.

The doctor has made a very careful subject and has conducted scientific examinations to prove these points.

We can readily see by the above that it is dangerous for anyone to use these preservatives to any great extent in their food. If they do ill results will be very likely to follow.

While we have, in the past, done quite a little work along these lines the growing use of these preservatives or the endeavors to

use them warrant our taking more energetic measures than ever before to stop their use without labelling. This will be one of the important parts of our work during the coming year.

COMMERCIAL FEEDING STUFFS.

The law regulating the sale of Concentrated Commercial Feeding Stuffs is one of importance to all consumers in the State. The provisions of this law have been fully explained in previous reports and the law has been sent to all dealers. This law in connection with all the laws under which this department is working is now published in pamphlet form and can be had by any one upon application to this office. Under this law the manufacturer or dealer must have his name and address; name of the feeding stuff; and the percentage of crude fat and protein branded on each bag or put on a tag attached to the package.

In our examinations throughout the State we find that some of the manufacturers fail to send the analyses of their feeding stuffs upon shipment of their goods in bulk. This should always be done and dealers should insist upon receiving same. We find, also, some of the feeds which are sold in bags are not branded or tagged as the law requires. We would call the attention of all dealers to this and warn them that this law must be complied with.

OUR PURE FOOD LAWS.

The pure food laws of Connecticut are now printed in pamphlet form and can be had upon application, by anyone, to this office.

We have special laws governing the sale of Imitation Butter, Renovated Butter, Tub Butter, Vinegar and Molasses, which are administered by this department. Our general pure food law and the law regulating the sale of Concentrated Commercial Feeding Stuffs are carried out by the Experiment Station, at New Haven, in connection with department.

Said Experiment Station have taken a large number of samples of food products and analyzed them during the year; and in accord with the provisions of the pure food laws have returned to this department a record of all those samples which were found adulterated together with the name of the adulterant. Upon the receipt of these returns from the Experiment Station this department has at once sent notice to the dealer from whose stock the samples were taken, said notice being by registered letter containing a printed form which is filled out with the name of the dealer, the article sold, the label, date of purchase, and by whom; together with the result of the analysis and the name of the adulterant; and a copy of the section of the law relating to this point. After this registered letter has been sent and the receipt therefor returned to this office this department then makes an examination of the stores where these articles were sold and if the same kinds are found on sale samples are again taken and if the analysis again shows adulteration the parties are prosecuted.

The following are the results of examinations under our special law and those returned to this department from the Experiment Station.

EXAMINATIONS OF BUTTER.

- Furnham Brothers, Greenwich, Gold Medal Prints.
 Knapp & Studwell, Greenwich,
 Clover Leaf Print, Gold Medal Print Gold Medal Tub, Renovated
 Tub.
 Bain & Hackett, Greenwich, Gold Medal Prints, Gold Medal Tub.
 J. L. Mahoney, Greenwich,
 Fancy Elgin, Butternut Prints, Gilt Edge Creamery Tub.
 G. A. Finch, Greenwich,
 Fairburg Tub, Gold Medal Tub, Gold Medal Prints.
 S. A. Moshier, Greenwich,
 Gold Seal Prints, Gold Seal Tub, Fox River Prints, Fox River
 Tub, Gold Medal Prints, Pinney & Geddes Golden Rod Tub,
 Gilt Edge Tub, Rockdale Tub.
 John Boles, Greenwich, Gold Medal Tub, Gold Medal Prints.
 Acker, Merrill & Condit Co., Greenwich,
 Rockdale Prints, Mayflower Prints, Ancehat Prints, Elgin Tub.
 Cohen Bros., Greenwich,
 Gold Medal Tub, Renovated Tub, Gold Medal Prints, Petit &
 Read Prints.
 G. M. Rich, Greenwich, Gold Medal Tub.
 O. D. Tuttle, Greenwich,
 Rosemary Prints, W. I. Young & Co. Creamery Tub.
 Windsor Dairy, Greenwich, Windsor Prints, Renovated Tub.
 T. H. McGee, Stamford, Rockdale Prints.
 O. S. Brown, Stamford, Gold Medal Tubs, Gold Medal Prints.
 Empire State Tea Co.
 T. Barnett, Mgr. Stamford, Clover Farm Creamery Tub.
 A. G. Weed, Stamford,
 Elgin Creamery, Tub, Stamford Creamery Prints.
 Acker Merrill & Condit Co., Stamford,
 Mayflower Prints, Ancehat Prints, Mayflower Tub.
 Samuel Price, Stamford,
 Spring Branch Creamery, Western Creamery Tub, Gold Seal
 Prints.
 H. L. Wood, Stamford, Fairbury Creamery Tub, Fairbury Prints.

- I. L. Smallhorn, Stamford, Gold Medal Prints, Fairbury Creamery Tub.
 C. E. Knapp, Stamford, Rockdale Prints.
 Branch of Brown & Webb, Stamford, John Scholl & Bro. Tub.
 Lord & Weir, Stamford, Gold Medal Prints.
 P. W. Shea, Stamford, Western Creamery Tub.
 Thos. Pregaiso, Stamford, Tub Butter.
 Consol. Milk & Cream Co.,
 W. F. Waterbury Mgr., Stamford,
 Creamery Butter made at Creamery, Sweet Butter.
 N. Y. Provision Co., Stamford, Gold Medal Print, Scholls' Creamery Tub.
 H. S. Deskham, Stamford,
 Gold Medal Prints, Standard Creamery Prints, Western Cream-
 ery Tubs.
 Geo. A. Ferris, Stamford,
 Gold Medal Prints, Gold Medal Tub, Renovated Tub.
 C. L. Reece, Stamford,
 Gold Medal Tub, Vermont Creamery Tub, Renovated Tub, Gold
 Medal Prints.
 C. Anderson & Co., Stamford, Western Creamery Tub.
 Brown & Webb, Stamford, Gold Medal Prints, Western Creamery Tub.
 Abe Cohen, Stamford, Gold Medal Prints.
 J. Sullivan, Stamford, Best Creamery Tub.
 Morris Gordon, Stamford, Gold Medal Tub.
 Wm. Barton, Stamford, Brookfield Creamery Tub.
 G. E. Fredericks, So. Norwalk,
 Fairbury Creamery Tub, Renovated Butter.
 Central Food Co., So. Norwalk,
 J. Scholl's Creamery Tub, Spring Branch Creamery.
 Chas. E. Seymour, So. Norwalk,
 Bridgewater Creamery Tub, Bridgewater Creamery Prints, Gold
 Medal Tub.
 Lorenzo Dibble, So. Norwalk, Gold Medal Tub, Gold Medal Prints.
 Lee Tea & Butter Store, So. Norwalk,
 Best Tub Butter, Oakland Tub Butter, Good Table Butter, Gold
 Medal Prints.
 United Grocery Co., So. Norwalk,
 Gold Medal Prints, Elgin Creamery Tub.
 M. Vogel, So. Norwalk, Western Creamery Tub.
 L. Joseloff, So. Norwalk,
 Fairbury Creamery Tub, Gold Medal Prints, Gold Medal Tub,
 Edwin Wilcox, So. Norwalk,
 Fairbury Creamery Tub, Aspetuck Creamery Prints.

N. Y. Grocery Co., So. Norwalk,	Elgin Creamery Tub.
H. F. Clark, So Norwalk,	Meadow Gold Print.
C. Becker, So. Norwalk,	Western Creamery Tub.
F. D. Lawton, So. Norwalk,	
Fairbury Creamery Tub, Fairbury Creamery Print, St. Albans Print, Renovated Tub.	
The New Century Market, So. Norwalk,	Gold Medal Prints.
Finney & Benedict, Norwalk,	St. Albans Print, St. Albans Tub.
C. L. Glover, Norwalk,	Gold Medal Prints, Western Tub Butter.
N. W. Benedict, Norwalk,	St. Albans Creamery Tub.
The Union Grocery Co., Norwalk,	Brookfield Creamery Tub.
Raymond & Co., Norwalk,	Gold Seal Tub, Gold Seal Print.
Betts & Van Buren, Norwalk,	St. Albans Prints, Fairbury Tub.
Grand Central Grocery Co., Norwalk,	John Scholls' Creamery Tub.
New York Grocery Co., Norwalk,	
	Elgin Creamery Tub, Renovated Prints.
The Great Atlantic & Pacific Tea Co., Norwalk,	Elgin Creamery Tub.
C. Beers, Danbury,	Aspetuck Creamery Tub.
W. B. Baldwin, Danbury,	Fairbury Creamery Tub, Clover Farm Prints.
G. S. Brasted, Danbury,	Renovated Prints, Sage Prints.
R. Krakow, Danbury,	Renovated Butter Prints.
The Danbury Market, Danbury,	Renovated Prints.
J. Knowlton, Danbury,	Brookfield Creamery Prints.
M. McPhelenny Est., Danbury,	
	Brookfield Creamery Tub, Brookfield Creamery Prints.
C. R. Travis & Son, Danbury,	Dairy Butter in Stone Pots.
E. C. Marcloch & Bro., Danbury,	Brookfield Creamery Print.
N. Y. Cash Store,	
C. Anderson & Co. Prop. Danbury,	Elgin Creamery Tub.
D. E. Katcham, Danbury,	Western Creamery Tub, Gold Medal Prints.
Mike Cavotti, Danbury,	Renovated Tub, Renovated Prints.
G. H. Vermilyea, Danbury,	
Fairbury Creamery Tub, Ashton Creamery Prints, Western Creamery Tub.	
Danbury Grocery Co., Danbury,	Brookfield Creamery Tub.
The Village Store, Danbury,	
	Western Creamery Tub, Village Store Prints.
Robertson & Menzies, Danbury,	Gold Seal Print, Gold Seal Tub.
D. W. Ehle, Danbury,	
	Gold Medal Tub, Renovated Prints, Gold Medal Prints.
Great Atlantic & Pacific Tea Co., Danbury,	Elgin Creamery Tub.
M. J. Barrett, Danbury,	Gold Medal Prints, Renovated Prints.

- M. J. Shanley, Danbury,
St. Albans Tub, Fairbury Tub, Gold Medal Tub, Gold Medal Prints.
- C. Charles, Danbury, Farmers Butter.
A. Jardon, Danbury, Fairbury Tub, Gold Medal Prints,
Mrs. P. McGrath, Danbury, Gold Seal Prints.
Mrs. Gelda, Danbury, Brookfield Prints.
Danbury Grocery Co., Danbury, Brookfield Creamery Tub.
Mrs. F. Oetzel, Danbury, Gold Medal Print, Brookfield Print.
Lena Libertina, Danbury, Renovated Prints, Creamery Tub.
P. McEnerney & Sons, Derby, Gold Medal Tub, Goshen Creamery.
Alexander Horbal, Derby, Western Creamery Tub, Renovated Tub.
G. Dzladiak, Derby,
Rogers Farm Dairy Tub, Gold Medal Prints, Sweet Tub.
- Morris Shield, Derby, Western Creamery Tub.
D. Vaccaro, Derby, Gold Medal Prints.
Derby Cash Market, Derby, Gold Medal Prints.
City Market, Derby, Gold Medal Prints.
N. Y. Cash Grocery, Derby, Elgin Creamery Tub, Renovated Print.
Peoples Grocery Co. (Logan Bros), Derby, Elgin Creamery Tub.
Geo. C. Schuessler, Derby, Colonial Creamery Print.
D. M. Welch & Son, Derby,
Fairbury Creamery Tub, Renovated Tub, Berkshire Hills Print.
- Andsager & Plumb, Derby,
Meadow Gold Creamery, Renovated Tub, Gold Medal Prints,
Renovated Prints.
- Wray & Co., Shelton,
Gold Medal Tub, Renovated Tub, Gold Medal Prints, Renovated Prints, St. Albans Prints.
- The Wheeler Co., Shelton,
Western Creamery Tub, Goshen Creamery, Renovated Prints.
- J. C. Beard, Shelton,
St. Albans Creamery Tub, Gold Medal Prints, Silver Spring Print.
- D. Donovan, Shelton,
A. C. Creamery, Tub, Western Creamery Tub, Farmers Butter.
- George F. Cook, Shelton,
Gold Medal Prints, Ashton Prints, Fairburg Creamery Tub,
Brookfield Prints, Farmers Prints.
- J. L. Ballou, Shelton,
St. Albans Creamery Tub, York State Tub, St Albans Prints.
- R. F. Cuddihy, Derby,
Gold Medal Tub, Gold Medal Print, Mad River Valley Print,
Diadem Print, Renovated Print,

T. Bergin, Derby, Gold Medal Prints, Western Creamery Tub.
 Chas. F. Rowan, Derby, Ashton Creamery Prints.
 Shaw & Greene, Derby, Fairbury Tub, Ashton Prints.
 James McEnerney, Derby, Clover Hill Print, York State Creamery Tub.
 G. W. Coggsawell, Derby, Aspetuck Creamery Print, Gold Medal Tub, Gold Medal Print.
 A. H. Yudkin, East Derby, Gold Medal Tub.
 E. E. Dunbar & Co., East Derby, Rockdale Creamery.
 J. Morey, Bridgeport, Western Creamery, Clover Leaf Tub.
 J. A. Ronan, Bridgeport, Diadem.
 Robert W. Parrott, Bridgeport, Fairbury Creamery Tub, Egremont Creamery Prints.
 Logan Brothers, Bridgeport, Elgin Creamery Tub.
 W. B. Meyer, Bridgeport, Western Creamery Tub.
 John Reuther, Bridgeport, York State Creamery Prints.
 J. B. Sullivan, Bridgeport, York State Creamery Tub, Renovated Tub, Gold Medal Prints.
 Jesse Lund (Star Market), Bridgeport, Western Creamery Tub.
 M. M. Nagle, Bridgeport, Keystone Prints.
 Great A. & P. Tea Co., Bridgeport, Elgin Creamery Tub.
 J. Schwarzkopf, Bridgeport, Western Creamery Tub, Diadem Prints.
 The Village Store, Bridgeport, Village Store Prints, Western Creamery Tub.
 A. M. Galla, Bridgeport, Creamery Tub.
 A. L. Rome, Bridgeport, Gold Medal Tub, Gold Medal Prints, Renovated Tub.
 R. Neupert, Bridgeport, Renovated Tub, Renovated Prints.
 A. Fraenza, Bridgeport, Renovated Tub, Colonial Creamery Prints.
 M. Boone, Bridgeport, Best Creamery Tub.
 A. B. Relch, Bridgeport, Best Creamery Tub.
 D. J. Kenney, Bridgeport, Western Creamery Tub, Renovated Tub.
 Mrs. A. Rabinowski, Bridgeport, Gold Medal Tub.
 Geo. A. Robertson, Bridgeport, Egremont Creamery Prints, Iowa Creamery Tub, Iowa Creamery No. 2, Renovated Prints.
 Bridgeport Public Market, Bridgeport, York State Creamery Tub, Western Creamery Tub, Imitation Creamery Tub, Renovated Prints, Lyme Creamery Prints.
 Bommos & Biltz, Bridgeport, Brookfield Creamery Prints.

The Great A. & P. Tea Co., Bridgeport, Elgin Creamery Tub.
 R. T. Whiting, Bridgeport, Elington Creamery Prints, Keystone Creamery Tub.
 H. Isenberg & Co., Bridgeport, . Gold Medal Tub, Gold Medal Prints, Renovated Tub, Renovated Prints.
 Mrs. A. J. Rehwinkel, Bridgeport, Lenox Creamery Prints.
 Chas. McCarthy, Bridgeport, Gold Medal Tub, Cooking Butter.
 J. J. Conway, Bridgeport, Diadem Creamery Tub, Western Creamery Tub.
 Lewis Brothers, Bridgeport, Fairbury Creamery Tub, York State Creamery Tub, Granby Prints.
 G. A. Mayer, Bridgeport, Brookfield Creamery Prints.
 G. C. & A. L. Stewart, Bridgeport, Heath Prints, Elgin Creamery Tub.
 Wm. Chew, Bridgeport, Egremont Prints, Western Creamery Tub.
 G. W. Whitney, Bridgeport, Egremont Prints, Western Creamery Tub, Gold Medal Prints.
 I. Oppenheim, Bridgeport, Gold Medal Prints, Western Creamery Prints.
 D. E. McNamara, Bridgeport, Renovated Prints, Gold Medal Tub.
 The Village Store, Bridgeport, Elgin Creamery Tub, Village Store Prints.
 J. Goldberger, Bridgeport, Keystone Creamery Prints.
 Logan, Brothers, Bridgeport, Western Creamery Tub.
 Geo. E. Elwood, Bridgeport, Keystone Tub, Keystone Prints.
 W. H. Redding, Bridgeport, Keystone Prints, Renovated Prints, Western Creamery Tub.
 S. E. Vincent, Bridgeport, Western Creamery Tub, Western Creamery Prints.
 E. Lundin, Bridgeport, Gold Medal Prints, Rogers Farm Dairy Tub.
 Wheeler & Co., Bridgeport, Fairbury Creamery Tub.
 The Coe & White Co., Bridgeport, Elgin Creamery Tub, Renovated Prints, Rockdale Prints.
 J. Lifshitz, Bridgeport, Western Creamery Tub.
 S. Majoney (Main St. Butter Store), Bridgeport, Extra Elgin Creamery Tub, Second Creamery Tub, Cooking Tub, Egremont Prints.
 B. Liebsher & Son, Bridgeport, Western Creamery Tub.
 E. A. Sherwood, Bridgeport, Brookfield Creamery Tub.
 Edward Finlan, Bridgeport, H. H. Creamery Prints, York State Creamery Tub.

- A. Ruenn, Bridgeport,
Fairmount Creamery Prints, Clover Leaf Creamery Tub.
- M. M. Burch, Bridgeport,
Egremont Creamery Prints, Western Creamery Tub.
- S. Silverstone, Bridgeport, Gold Medal Tub, Gold Medal Prints.
- A. Lung, Bridgeport, York State Creamery Tub.
- T. A. Lockhart, Bridgeport,
Egremont Prints, Diadem Prints, Renovated Prints.
- D. E. McNamara, Bridgeport,
Best Creamery Tub, Renovated Tub.
- C. Oppenheim, Bridgeport,
Gold Medal Tub, Gold Medal Prints, Renovated Tub.
- A. J. Keane, Bridgeport,
Diadem Creamery Prints, Hunters Paradise Farm Prints.
- Richard Schmidt,
Western Creamery Tub, St. Albans Creamery Tub.
- J. F. Kelley, Bridgeport, Western Creamery Tub.
- E. Wright, Bridgeport, Gold Medal Prints.
- T. Halsey, Bridgeport, Gold Medal Tub, Gold Medal Prints.
- L. M. Lund, Bridgeport, Gold Medal Prints, Western Creamery Tub.
- The Logan Bros. Co., Bridgeport, Elgin Creamery Tub.
- Osborne Bros., Bridgeport, Extra Creamery Tub, Diadem Prints.
- Chas. W. Held, Bridgeport, Keystone Prints.
- E. R. Foote, Bridgeport,
Western Creamery Tub, Renovated Tub, Egremont Creamery Prints.
- John Mondezski, Bridgeport,
Renovated Tub, Western Creamery Tub.
- D. E. McNamara, Bridgeport,
Western Creamery Tub, Renovated Prints.
- Geo. O'Connell, Bridgeport,
Diadem Creamery Prints, Western Creamery Tub.
- R. Dietz, Bridgeport, Gold Medal Tub.
- Joseph Zbysrlewski, Bridgeport, Renovated Tub.
- P. Shapiro, Bridgeport, Gold Medal Tub.
- J. J. Linehan, Bridgeport,
St. Albans Creamery Tub, Egremont Prints, Renovated Prints.
- John F. Chattos, Bridgeport, Brookfield Creamery Prints.
- S. Jontos, Bridgeport,
Extra Creamery Tub, Brookfield Creamery Prints.
- Ed. Troy, Bridgeport, Best Creamery Tub, Gold Medal Prints.
- D. Calman, Bridgeport, Gold Medal Tub.

- P. D. Lyons, Bridgeport, Egremont Prints, Elgin Creamery Tub.
M. W. Dick, Bridgeport, Western Creamery Tub.
H. Hayward, Bridgeport, Egremont Creamery Prints.
The Logan Bros. Co., Bridgeport, Elgin Creamery Tub.
John Frank, Bridgeport,
Gold Medal Prints, Egremont Prints, Brookfield Creamery
Prints.
Rudolph, Baumann, Bridgeport,
Egremont Creamery Prints, Standard Creamery Tub, Western
Creamery Tub.
Anton Basserman, New Haven,
York State Creamery Tub, Franklin County Prints, Gold Medal
Prints, Renovated Prints.
John A. Doyle, New Haven,
Fairbury Creamery Tub, Ashton Creamery Prints.
T. J. Coffey, New Haven, Gold Medal Tub, Gold Medal Prints.
Morris Kent, New Haven, Renovated Tub, Gold Medal Prints.
F. Collett, New Haven, Gold Medal Prints, Fairbury Creamery Tub.
D. Hickey, New Haven, Gold Medal Tub, Gold Medal Prints.
Mrs. J. Brody, New Haven,
St. Albans Creamery Tub, Renovated Prints.
J. J. Dennon, New Haven,
Gold Medal Tub, Gold Medal Prints, Fairbury Creamery Prints,
Fairbury Creamery Tub.
Wm. Webber, New Haven, York State Creamery.
Wm. Sisbe, New Haven, York State Creamery Tub.
R. Hanrahan, New Haven, Gold Medal Prints.
H. J. Finnegan, New Haven, Gold Medal Tub, Gold Medal Prints.
McGovern Bros., New Haven,
Gold Medal Tub, Fairbury Creamery Tub, St. Albans Cream-
ery Prints.
G. J. Russell, New Haven, Fairbury Creamery Tub.
M. McGarey, New Haven, Cambridge Creamery Prints.
James Harhen, New Haven, Renovated Prints.
A. Lander, New Haven,
Gold Medal Tub, Gold Medal Prints, Renovated Tub.
M. C. Dingwald,
Litchfield Creamery Tub, Elgin Creamery Tub, Ladle Tub, Un-
salted Prints.
Logan Brothers, New Haven,
Elgin Creamery Tub, Renovated Prints.
E. Schoenberger & Sons, New Haven,
St. Albans Creamery Tub, Fairbury Creamery Tub, Renovated
Tub, B. B. Creamery Prints.

- John Olson, New Haven, Gold Medal Tub.
 Chas. Loeffel, New Haven, Gold Medal Prints.
 J. Kramer, New Haven,
 Renovated Tub, Colonial Creamery Tub, Colonial Prints, Renovated Prints.
 The Boothe Meat Co., New Haven, Print Butter (no brand).
 Alex. Kalleysewsky, New Haven, Renovated Tub.
 Joseph Molloy, New Haven, Franklin Co. Creamery Tub.
 J. Kramer, New Haven,
 Colonial Creamery Tub, Renovated Tub, Colonial Prints.
 C. W. Knoff, New Haven, Renovated Tub.
 M. C. Dingwall, New Haven,
 Litchfield Creamery Tub, Vermont Creamery Tub, Renovated Tub, White Clover Creamery Tub, Silver Spring Prints, Renovated Prints.
 E. Schoenberger, New Haven,
 Fairbury Creamery Tub, Renovated Tub, Renovated Prints, Durnham Creamery Prints, St. Albans Prints Ashton Prints, Gold Medal Tub,
 Geo. Jacobs & Bro., New Haven, Gold Medal Prints, Gold Medal Tub.
 D. M. Welch & Son, New Haven,
 Fairbury Creamery Tub, Renovated Tub, Renovated Prints, Gold Medal Prints, Fancy Elgin Tub in Prints.
 M. C. Dingwall, New Haven,
 Litchfield Creamery Tub, Vermont Creamery Tub, Elgin Creamery Tub, White Clover Creamery Tub, Green Valley Dairy (Renovated), Silver Spring Creamery Prints, Silver Spring Unsalted Prints, Renovated Butter.
 The Boothe Meat Co., New Haven, Fairbury Creamery Tub.
 S. Francesconi, New Haven, Renovated Butter.
 New England Grocery Co., New Haven,
 Gold Medal Prints, Granby Creamery Prints.
 J. H. Dillon, New Haven, Gold Medal Tub, Gold Medal Prints.
 F. J. Markle, New Haven, Gold Medal Tub, Gold Medal Prints.
 H. M. Tower, New Haven, Helena Prints, Fairbury Creamery Tub.
 Logan Brothers, New Haven, Elgin Creamery Tub, Renovated Prints.
 W. R. Bailey, New Haven,
 Gold Medal Tub, Gold Medal Prints, Cambridge Creamery Prints.
 N. J. Henahan, New Haven, B. C. A. Creamery Prints.
 S. Stillman, New Haven, Sweet Butter, Renovated Prints.
 C. A. Warner, New Haven, Renovated Prints.
 T. J. Coakley, New Haven, Renovated Prints.

- M. Mendelsohn, New Haven, Renovated Tub.
 T. Albanese, New Haven, Creamery Tub (Renovated.)
 M. E. Fett, New Haven, York State Creamery Tub, Renovated Tub.
 Fred Landroth, New Haven,
 Gold Medal Tub, St. Albans Prints, Renovated Prints.
 J. Hauser, New Haven, Fairbury Creamery Tub.
 Wray & Co., New Haven, Gold Medal Tub, Gold Medal Prints.
 C. C. Stevens, New Haven,
 Renovated Tub, St. Albans Prints, Western Creamery Tub.
 S. S. Adams, New Haven,
 Best Elgin Creamery Tub, Gold Medal Prints, Renovated Prints.
 R. E. Kirst, New Haven,
 Cambridge Creamery Tub, Cambridge Creamery Prints.
 R. F. Copeland, New Haven, Gold Medal Tub.
 A. Dunham, New Haven, Fairbury Creamery Tub
 A. Schmidt, New Haven,
 St. Albans Creamery Tub, Farmers' Prints, Renovated Prints.
 Geo. Wienhusen, New Haven,
 Fairbury Creamery Tub, Gold Medal Prints, Renovated Prints.
 Geler, Gallery & Geler, New Haven,
 St. Albans Creamery Prints, Fairbury Creamery Tub.
 Dan Dwyer, New Haven, St. Albans Creamery Tub.
 C. F. Curtin, New Haven,
 Fairbury Creamery Tub, Canton Creamery Prints.
 Boothe Meat Co., New Haven, Cambridge Creamery Prints.
 A. L. Bailey, New Haven, York State Creamery Prints.
 W. J. O'Keefe, New Haven,
 Fairbury Creamery Tub, Gold Medal Prints.
 Wm. W. Merwin, New Haven, Renovated Tub.
 Wm. Costello, New Haven, Cambridge Creamery Tub.
 Gibbons Bros., New Haven,
 Gold Medal Prints, Cook Hill Farm Prints, St. Albans Tub,
 Renovated Tub.
 W. E. Waterbury, New Haven,
 Gold Medal Tub, Gold Medal Prints, Renovated Prints.
 Chris Baun, New Haven, Renovated Tub, Gold Medal Prints.
 S. S. Adams, New Haven,
 Gold Medal Tub, Gold Medal Prints, Renovated Prints, Ren-
 ovated Tub.
 Maher Bros., New Haven,
 Fairbury Creamery Tub, St. Albans Prints, Renovated Prints.
 Geo. Dahlney, New Haven, Renovated Tub, Green Valley Prints.

- W. J. O'Keefe, New Haven,
Gold Medal Prints, Fairbury Creamery Tub.
- T. P. Smallman, New Haven,
Renovated Tub. Ashton Creamery Prints.
- Otto Dietter, New Haven,
T. C. A. Creamery Prints, Cambridge Prints, Gold Medal Prints,
Elgin Creamery Prints.
- H. Alpert, New Haven,
Gold Medal Prints.
- J. T. Corey, New Haven,
Creamery Tub. Creamery Tub.
- L. Scheaner, New Haven,
Gold Medal Prints, Ashton Prints, Western Creamery Tub.
- S. S. Adams, New Haven,
Elgin Creamery Tub, Renovated Tub, Renovated Prints, Gold
Medal Prints.
- Russell Bros., New Haven, Vermont Creamery Tub, Renovated Tub.
Enterprise Specialty Co., New Haven,
Gold Medal Tub, Renovated Tub.
- The Carlson Tea & Butter Co., New Haven,
Gold Medal Tub, Fairbury Creamery Tub.
- Wm. Stietz, New Haven,
Franklin Creamery Tub, Franklin Creamery Prints, Renovated
Prints.
- H. L. Andrew, New Haven,
B. C. A. Creamery Prints, Gold Medal Prints, Renovated Prints,
Western Creamery Tub.
- F. J. Markle, New Haven,
Elgin Creamery Tub, Fairbury Creamery Tub, Gold Medal
Prints, Fairbury Creamery Prints.
- Paul Jente & Bro., New Haven,
Suffield Creamery Prints, Gold Medal Prints, Gold Medal Tub.
- E. Van Buren & Co., New Haven,
Handy's Honey Dew Prints, St. Albans Prints, Ashton Prints,
Colonial Prints, Fairbury Creamery Tub.
- The Boothe Meat Co., New Haven,
Fairbury Creamery Tub, Cambridge Prints.
- A. D. Hoppman, New Haven, Elgin Creamery Tub, Renovated Prints.
- Pohlman & Scanlon, New Haven,
Cambridge Prints, Waterbury (Vt.) Creamery Prints, Fairbury
Creamery Tub.
- Geo. E. S. Miller, New Haven, Fairbury Creamery Tub.
- S. Masumian & Co., New Haven,
Fresh Creamery Tub, Gold Medal Prints, Renovated Prints.
- A. V. Lindsey, New Haven, Fairbury Creamery Tub, St. Albans Prints.

- W. D. Hall, New Haven,
Gold Medal Creamery Tub, Gold Medal Prints.
- Wray & Co., New Haven,
Gold Medal Tub, Cambridge Creamery Tub, Cambridge Prints.
- H. A. Pierce, New Haven,
Cambridge Creamery Prints, Cambridge Creamery Tub.
- B. Alper, New Haven, Gold Medal Tub, Renovated Tub.
- Henry Woodruff, New Haven, Western Creamery Prints.
- M. Veznain, New Haven, Gold Medal Tub, Gold Medal Prints.
- Mrs. E. Rasche, New Haven, Renovated Tub, Gold Medal Prints.
- Henry Jacobs, Ansonia, Gold Medal Prints.
- T. U. Wentworth, Ansonia,
St. Albans Creamery Prints, St. Albans Creamery Tub, Fairbury
Creamery Tub, Renovated Tub.
- D. Barnett, Ansonia, Gold Medal Tub.
- John Driscoll, Ansonia, Gold Medal Tub.
- U. H. Barrett, Ansonia, York State Creamery Tub.
- A. C. Christensen, Ansonia,
Granby Creamery Prints, Colonial Prints, Elgin Creamery Tub.
- Ansonia Trading Co., Ansonia, Gold Medal Prints, Renovated Tub.
- W. H. Bronson, Ansonia,
Canton Creamery Prints, York State Creamery Tub, Renovated
Prints.
- D. M. Welch & Son, Ansonia,
Fairbury Creamery Tub, Renovated Tub, Gold Medal Prints.
- People's Grocery Co., Ansonia, Elgin Creamery Tub.
- West Side Market, Ansonia,
York State Creamery Tub, Gold Medal Prints.
- P. W. Fogarty, Ansonia, Brookfield Creamery Tub, Renovated Tub.
- G. E. May, Ansonia, Western Creamery Tub, Gold Medal Prints.
- Dimitro Sydorick, Ansonia, Gold Medal Tub.
- T. Coleman, Ansonia, Fairbury Creamery Tub.
- W. Rich, Ansonia, Gold Medal Tub.
- P. J. Noonan, Ansonia, Fairbury Creamery Tub.
- Chas. Arandaski, Ansonia, Diadem Creamery Prints.
- T. W. Kelly, Ansonia, Gold Medal Prints, Meadow Gold Tub.
- Wm. J. Sully, Ansonia, Gold Medal Tub.
- P. J. Donovan, Ansonia,
Gold Medal Tub, Gold Medal Prints, Renovated Tub.
- The Camp & Rugg Co., Seymour,
York State Creamery Tub, Blue Grass Prints.
- R. M. Parsons, Seymour, York State Creamery Tub, Renovated Prints.
- Baldwin & Mills, Seymour, Renovated Prints, Rockdale Prints.

H. O. Chatfield, Seymour, Gold Medal Tub, Gold Medal Prints.
 S. W. Buckingham, Seymour, York State Creamery Tub.
 A. Y. Beach, Seymour, York State Creamery Tub.
 J. Mahoney, Seymour, Gold Medal Tub, Gold Medal Prints.
 Mrs. A. C. Dean, Seymour,
 Canton Creamery Prints, Owego Creamery Tub.
 P. G. Newton, Seymour, Western Dairy Tub.
 Coleman Bros., Seymour, Gold Medal Tub, St. Albans Prints.
 A. Volkmar, Seymour,
 Renovated Prints, Gold Medal Prints, York State Creamery Tub.
 A. Dzladic, Seymour, Renovated Prints.
 Charles Tocchio, Waterbury, Gold Medal Prints, Brookfield Prints.
 Robert Alcherion, Waterbury, Brookfield Prints, Renovated Prints.
 Lee Bros., Waterbury,
 Gold Medal Prints, Renovated Prints, Western Creamery Tub.
 James Ring, Waterbury, Gold Medal Prints.
 P. S. Corden, Waterbury, Gold Medal Tub.
 J. H. Lachance, Waterbury, Gold Medal Prints, Renovated Tub.
 John McCarthy, Waterbury, Gold Medal Tub, Gold Medal Prints.
 James Eagan, Waterbury,
 Gold Medal Prints, Blue Grass Prints, Rockdale Prints, Renovated Prints, York State Creamery Tub.
 Cruess Bros., Waterbury,
 Gold Medal Prints, Meadow Gold Prints, Granby Prints, Renovated Prints, York State Creamery Tub.
 John McCarthy, Waterbury,
 York State Creamery Tub, Gold Medal Prints, Granby Prints, Beach Prints, Renovated Prints.
 M. Doran, Waterbury, York State Creamery Tub.
 John Santora, Waterbury,
 Beach Creamery Prints, Western Creamery Tub.
 Miss G. M. Brink, Waterbury,
 Beach Creamery Prints, Renovated Prints.
 Wray & Co., Waterbury, Gold Medal Tub, Gold Medal Prints.
 Chas. E. Peck, Waterbury, Fairbury Creamery Tub.
 Gallagher Bros., Waterbury, Rockdale Creamery Prints.
 The American Grocery Co., Waterbury,
 Gold Medal Tub, Gold Medal Prints, Renovated Prints.
 The Spencer & Pierpont Co., Waterbury,
 Sage Creamery Prints, Beach Prints, Gold Medal Prints, Gold Medal Tub.
 Henry Beauregard, Waterbury, Renovated Prints, Brookfield Prints.
 Alfonso Matarazzo, Waterbury, Woodlawn Prints.

- Wm. Beck, Waterbury,
Fairbury Creamery Tub, Renovated Tub, Renovated Prints.
Pennsylvania Mdse. Co., Waterbury,
Blue Grass Prints, Fairbury Tub, Granby Prints.
- C. L. Rogers, Waterbury,
St. Albans Prints, Gold Medal Prints, Renovated Prints.
- M. Spirt, Waterbury, Brookfield Creamery Tub.
W. N. Valee, Waterbury, Renovated Prints, Fairbury Tub.
Public Market, Waterbury, Gold Medal Prints, Renovated Tub.
Gooura Bros., Waterbury, Gold Medal Tub, Gold Medal Prints.
- K. H. Dickson, Waterbury,
Beach Creamery Prints, Gold Medal Prints, Renovated Prints,
York State Creamery Tub.
- Bouser Bros., Waterbury, XXXX Creamery Prints, Renovated Prints.
C. B. Sanderson, Waterbury, St. Albans Prints, Renovated Prints.
- M. J. Fogg, Waterbury,
Fairbury Creamery Tub, St. Albans Tub, Goshen Prints, Canton
Prints, Gold Medal Prints.
- Albert Bley, Waterbury, Gold Medal Prints, Gold Medal Tub.
W. N. Ladd, Waterbury,
Beach Creamery Prints, Fairbury Creamery Tub.
- M. F. Moore, Waterbury,
Fairbury Creamery Tub, Avon Creamery Prints, P. & H.
(Cheshire) Prints.
- J. W. Burns, Waterbury, Meadow Gold Tub.
A. J. Vineburg, Waterbury, Renovated Prints, Sweet Butter.
- Abraham & Swenson, Waterbury,
Rockdale Creamery Tub, Blue Grass Prints, Renovated Prints.
Waterbury Co-operative Co., Waterbury,
Rockdale Creamery Tub, Gold Medal Prints, Blue Grass Prints,
Renovated Prints.
- W. E. Russell, Waterbury, Western Creamery Tub, Gold Medal Prints.
E. A. Say & Co., Waterbury, Gold Medal Tub, Sage Creamery Prints.
- H. R. Hotchkiss, Waterbury,
Granby Creamery Prints, Fairbury Creamery Tub.
- McKerracker Bros., Waterbury,
Sage Creamery Print, Gold Medal Tub, Renovated Print.
- W. F. McGrath, Waterbury, Renovated Prints.
- F. Benoit, Waterbury,
Blue Grass Creamery Prints, Renovated Prints, Elgin Creamery
Tub, Beach Creamery Prints.
- Joseph Thibault, Waterbury, Cow Brand Prints, Renovated Prints.

- Eagle Grocery Store, Waterbury,
Renovated Prints, Torrington Creamery Prints.
- P. T. Gervais, Waterbury,
Western Creamery Tub, Renovated Tub, Oleomargarine, Beach
Creamery Prints.
- S. N. Levin, Waterbury, Meadow Gold Prints, Renovated Prints.
The Hensett Gro. Co., Waterbury,
Gold Spring Prints, B. C. A. Creamery Prints, Fairbury Cream-
ery Tub.
- Cheeny Market, Waterbury, Gold Medal Prints, Renovated Prints.
The Woodruff Gro. Co., Waterbury,
York State Creamery Tub, Goshen Creamery Prints, Sage
Creamery Prints.
- H. B. Sanderson, Waterbury,
Sage Creamery Prints, Beach Creamery Prints, Fairbury
Creamery Tub.
- John Tato, Waterbury,
Sage Creamery Prints, Renovated Prints, Brookfield Prints,
Gold Medal Prints.
- D. J. McCarthy, Waterbury,
XXXX Creamery Tub, XXXX Creamery Prints, Farmers'
Prints, Renovated Prints.
- W. M. Foote, Waterbury,
Renovated Prints, Sage Creamery Prints, York State Creamery
Tub.
- R. W. Turnbull, Waterbury,
Gold Medal Prints, Renovated Prints, Meadow Gold Tub.
- Dauch & Co., Waterbury,
Meadow Gold Prints, Gold Medal Prints, Renovated Prints.
- The White Simmons Co., Waterbury,
Beach Creamery Prints, Goshen Creamery Prints, Renovated
Prints, Fairbury Creamery Tub.
- Thomas Kelley, Waterbury, Creamery Tub.
- The Union Supply Co., Waterbury, Renovated Tub.
- Boston Butter Store, Waterbury,
Western Creamery Tub, Renovated Tub, Second Grade Cream-
ery Tub, Rockdale Creamery Prints, Oleomargarine.
- Public Market, Waterbury,
Renovated Prints, Gold Medal Prints, Renovated Tub.
- Waterbury Market Co., Waterbury,
Renovated Prints, Gold Medal Prints, Meadow Gold Prints,
Rockdale Creamery Prints.

- M. Blanchette, Waterbury,
Granby Creamery Prints, Renovated Prints, Western Creamery Tub.
- A. B. Archambault, Waterbury,
Rockdale Creamery Prints, Rockdale Creamery Tub.
- A. Hadad, Waterbury, Renovated Tub.
- Mrs. M. Gagnon, Waterbury,
Rockdale Creamery Prints, Renovated Prints.
- John J. Bauser, Waterbury, Gold Medal Prints, Renovated Prints.
- G. W. McGregor, Waterbury,
Beach Creamery Prints, Bridgewater Prints, Gold Medal Tub, Renovated Prints.
- Chas. Gumpfer, Waterbury,
Meadow Gold Prints, Gold Medal Prints, Renovated Prints.
- J. F. Fitzgerald, Waterbury,
Granby Creamery Prints, Renovated Prints.
- L. S. Schick, Waterbury,
Granby Creamery Prints, Sweet Clover Renovated Prints.
- J. J. Dwyer, Waterbury,
York State Creamery Tub, Cheshire Creamery Prints.
- R. B. Lewis, Waterbury, Sage Creamery Prints.
- M. A. Hartnett, Waterbury, Meadow Gold Tub, Brookfield Prints.
- John J. Moore, Waterbury, Renovated Prints.
- C. Mulvy, Waterbury, Gold Medal Tub.
- Mrs. John Phelan, Waterbury, Renovated Prints.
- T. F. Coughlan, Waterbury, Renovated Prints.
- Martin J. Keefe, Waterbury,
Granby Creamery Prints, York State Creamery Tub.
- Wm. Carey, Waterbury, Brookfield Creamery Prints.
- John Kelly, Waterbury, Gold Medal Prints.
- Albert LeClair, Waterbury, Renovated Prints, Gold Medal Tub.
- Tom Kelly, Waterbury, Western Creamery Tub.
- Mrs. M. A. Thompson, Waterbury,
Granby Creamery Prints, York State Creamery Tub.
- D. J. Phelan, Waterbury,
Renovated Prints, Beach Prints, York State Creamery Tub.
- D. J. Delaney, Waterbury, Granby Creamery Prints, Gold Medal Tub.
- J. C. McEvoy, Waterbury,
Western Creamery Tub, Renovated Tub, Oleomargarine.
- C. H. Williams, Waterbury, Gold Medal Prints.
- Mary Malone, Waterbury, Renovated Prints, Renovated Tub.
- D. E. Maloney, Waterbury, Renovated Prints.
- C. J. McCarthy, Waterbury, Meadow Gold Tub.

Naugatuck Cash Market, Naugatuck,
 Standard Creamery Tub, Gold Medal Prints, Fox River Prints.
 W. F. Brennan, Naugatuck,
 Gold Medal Tub, Gold Medal Prints, Renovated Prints.
 Joseph Carlson, Naugatuck,
 Rockdale Creamery Tub, Fairbury Creamery Tub, Renovated
 Tub, Renovated Tub.
 H. D. Patteson, Naugatuck, York State Creamery Tub.
 C. A. Gray, Naugatuck, Gold Medal Prints.
 Peter Boylan, Naugatuck, Granby Creamery Prints.
 J. H. Kenney, Naugatuck, Brookfield Creamery Prints.
 H. H. Scofield, Prop., Naugatuck,
 Berkshire Hills Creamery Prints, York State Creamery Tub.
 J. C. Donovan, Naugatuck, Brookfield Creamery Prints.
 A. B. Galvin, Naugatuck, Meadow Gold Prints.
 Edward Doyle, Naugatuck, Renovated Prints.
 Mrs. N. J. McGraw, Naugatuck, Gold Medal Tub.
 P. H. Daley, Naugatuck,
 Fairbury Creamery Tub, Gold Medal Prints, Renovated Tub.
 I. E. Taylor, Naugatuck,
 Renovated Prints, Gold Medal Prints, Meadow Gold Prints.
 L. S. Moulthrop, Naugatuck,
 Berkshire Hills Creamery Prints, Gold Medal Prints, Jamestown
 Creamery Tub.
 E. Vagt, Naugatuck, Gold Medal Prints, Farmers' Butter.
 W. G. Davis, Naugatuck,
 York State Creamery Tub, Franklin County Creamery Prints.
 W. A. Brauner's, Naugatuck, Gold Medal Prints, Gold Medal Tub.
 H. N. Smith, Naugatuck, Brookfield Creamery Prints.
 H. H. Scofield, Naugatuck, York State Creamery Tub.
 The Union Supply Co., Naugatuck, Renovated Tub.
 Henry Menold, Union City, Gold Medal Prints, Renovated Tub.
 Hart E. Perkins, Union City,
 York State Creamery Tub, Renovated Prints, Berkshire Hills
 Prints.
 J. Welsman, Union City, Gold Medal Prints, Sweet Butter.
 D. M. Linsky, Union City, Renovated Prints, Renovated Tub.
 Peter Masonic, Union City, Renovated Prints.
 F. Wache & P. Trumber, Union City,
 Gold Medal Prints, Renovated Prints.
 A. F. McDermott, Union City,
 Renovated Prints, Gold Medal Prints, Farmers' Butter.
 Joseph Szitar, Union City, Renovated Prints.

- James Patterson, Union City, Gold Medal Prints, Renovated Prints.
 J. C. Regan, Union City,
 Gold Medal Prints, Gold Medal Tub, Renovated Prints.
 D. G. McGrath, Waterbury,
 Gold Medal Prints, Meadow Gold Prints, Renovated Prints,
 Gold Medal Tub, Renovated Tub.
 J. F. Cronan, Waterbury, Meadow Gold Prints, Gold Medal Prints.
 D. M. O'Brien, Waterbury, Gold Medal Tub.
 Prissavage Bros., Waterbury, Renovated Prints.
 J. Mitchell, Waterbury,
 Gold Medal Prints, Renovated Prints, Cow Brand Sweet Butter.
 Striculs & German, Waterbury,
 Renovated Prints, Gilt Edge, Blue Grass Prints.
 J. Baltrush, Waterbury,
 Rockdale Creamery Prints, Rockdale Creamery Tub, Renovated
 Prints.
 Joseph Kudirka, Waterbury,
 Renovated Prints, Rockdale Prints, Sweet Butter.
 Griszkauskas & Yoksza, Waterbury,
 Renovated Prints, XXXX Creamery Prints, Rockdale Creamery
 Prints, Rockdale Tub.
 E. P. Dunphy, Waterbury,
 Sage Creamery Prints, York State Creamery Tub.
 F. G. Lallier, Waterbury,
 Gold Medal Prints, Meadow Gold Prints, Brookfield Prints,
 Renovated Prints.
 A. Brunet, Waterbury, Renovated Tub, Renovated Prints.
 J. K. Camp, Winsted, Berkshire Prints, Dairy Butter.
 Omeara Lockett, Winsted,
 Renovated Prints, Meadow Gold Prints, Gold Medal Prints.
 McMan & Dolet, Winsted, Gold Medal Prints, Tunxis Creamery Prints.
 Deming & Phelps, Winsted,
 Tunxis Creamery Prints, Simsbury Creamery Prints, Gold
 Medal Prints.
 W. J. Brennan, Winsted, Meadow Gold Prints, Gold Medal Prints.
 King & Gay, Winsted,
 Tunxis Creamery Prints, Meadow Gold Prints, Farmers' Butter.
 H. C. Price, Winsted, Tunxis Creamery Prints, Meadow Gold.
 W. E. Franz, Winsted,
 Tunxis Creamery Prints, Meadow Gold Prints, Farmers' Butter.
 B. V. Pinney & Son, Winsted,
 Renovated Prints, Tunxis Creamery Prints, Meadow Gold Prints.

- C. E. Bristol, Winsted,
Tunxis Creamery Prints, Gold Medal Tub, Brookfield Creamery Prints.
- Thos. Glaster, Winsted, Gold Medal Prints, Renovated Prints.
- Baldwin & Moffatt, Winsted,
Tunxis Creamery Prints, Elgin Creamery Prints, Farmers' Prints.
- Newcity & Cooke, Winsted,
Renovated Prints, Tunxis Creamery Prints, Gold Medal Prints.
- Chas. R. Surdan, Winsted,
Tunxis Creamery Prints, Meadow Gold Prints, Gold Medal Prints, Renovated Prints.
- T. W. McCarthy, Winsted,
Gold Medal Prints, Tunxis Creamery Prints, Elgin Creamery Prints, Farmers' Prints.
- H. S. Comstock, Winsted,
Tunxis Creamery Prints, B. C. A. Creamery Prints, Farmers' Butter.
- A. B. Fancher & Son, Winsted, Gold Medal Prints.
- F. A. Stickles, Torrington,
Gold Medal Prints, Renovated Prints, Farmers' Butter.
- M. A. Hadad, Torrington, Farmers' Prints.
- M. T. McCarthy, Torrington,
Torrington Creamery Prints, Farmers' Butter.
- Barton Bros., Torrington,
Granby Creamery Prints, Torrington Creamery Prints, St Albans Prints.
- Torrington Co-operative Co., Torrington,
Goshen Creamery Prints, Farmers' Butter, Gold Medal Prints.
- B. Graziani, Torrington, Gold Medal Prints, Farmers' Butter.
- Geo. W. Main, Torrington,
Tunxis Creamery Prints, Gold Medal Prints, Torrington Prints, Farmers' Butter.
- N. Ofstrosky, Torrington, Renovated Prints.
- W. J. Williams, Torrington,
Torrington Creamery Prints, Gold Medal Prints, Renovated Prints.
- Theodor Lorenz, Torrington, Renovated Prints.
- C. H. Higley, Torrington,
Renovated Prints, Torrington Creamery Prints, Farmers' Butter.
- Wm. Mulcunry, Torrington,
Berkshire Creamery Prints, Torrington Creamery Prints, Farmers' Butter.

- James F. O'Meara, Torrington, Gold Medal Prints, Renovated Prints.
 S. A. McIntosh, Torrington,
 Gold Medal Prints, Brookwood Creamery Prints, Renovated Prints.
- N. Y. Butter House, Torrington,
 York State Tub, Creamery Butter, Western Creamery Tub, Oleomargarine.
- P. D. Vroom, Torrington, Renovated Prints, Farmers' Prints.
 J. Walsh, Portland, Brookfield Creamery Prints.
 David Barry, Portland, Gold Medal Prints.
 Chas. Gustafson, Portland, Meadow Gold Prints, Farmers' Butter.
 C. H. Bell, Portland,
 Fox River Prints, Fox River Tub, Farmers' Butter.
- W. H. Robinson, Portland, Gold Medal Prints, Renovated Prints.
 P. Sullivan, Portland, Western Creamery Tub, Farmers' Butter.
- John Branfield, Portland,
 Fairbury Creamery Tub, Ashton Creamery Prints, Renovated Prints, Farmers' Butter.
- O. Thompson & Co., Middletown,
 Renovated Prints, York State Creamery Tub.
- John J. Walsh, Middletown,
 St. Albans Prints, St. Albans Tub, Meadow Gold Prints, Renovated Prints.
- D. J. Hartman, Middletown,
 Gold Medal Prints, Higanum Creamery Prints, Renovated Prints, Elgin Creamery Tub.
- W. J. Trevithick, Middletown,
 Meadow Gold Prints, Gold Medal Prints, Rockdale Tub, Renovated Prints, Elgin Creamery Prints.
- Thos. J. Walsh, Middletown,
 Granby Creamery Prints, Renovated Prints, York State Creamery Tub.
- W. B. Griswold, Middletown,
 Cromwell Creamery Prints, Meadow Gold Prints, Gold Medal Prints, Renovated Prints.
- Gustafson & Berggren, Middletown,
 Millbrook Creamery Prints, Fairbury Tub, Renovated Tub.
- Wall, Donovan & Wall, Middletown,
 E. Haddam Creamery Prints, Fairbury Creamery Prints, Renovated Tub, Renovated Prints.
- Middletown Cash Grocery, Middletown,
 Elgin Creamery Tub, Gold Medal Prints.
- A. M. Bidwell, Middletown,
 Meadow Gold Prints, Gold Medal Prints, Cromwell Creamery

Prints, Farmers' Prints, Renovated Prints.

- C. M. Parmelee, Middletown, Cromwell Creamery Prints.
 O. H. Cone, Middletown,
 Orange County Creamery Tub, Renovated Tub, Ashton Creamery Prints, Cromwell Creamery Prints, Renovated Prints.
 R. A. Pease & Son, Middletown,
 Windsor Creamery Prints, Fairbury Creamery Tub.
 Riggs & Walker, Middletown,
 Cromwell Creamery Prints, Western Creamery Tub.
 L. B. Chaffee, Middletown,
 Fairbury Creamery Prints, Fairbury Creamery Tub.
 F. P. Brennan, Middletown,
 Cromwell Creamery Prints, Primrose Creamery Prints, Renovated Prints.
 G. H. Hedges, Middletown,
 Elgin Creamery Tub, Gold Medal Prints, Farmers' Butter.
 I. L. Coes Son, Middletown,
 Cromwell Creamery Prints, Brookside Creamery Prints, Gold Medal Prints, Gold Medal Tub.
 D. I. Chapman, Middletown,
 Cromwell Creamery Prints, York State Creamery Tub, Farmers' Butter.
 J. R. Lynch, Middletown,
 Green Valley Creamery Prints, Renovated Prints.
 W. K. Spence, Middletown,
 Ashton Creamery Prints, Renovated Prints, Farmers' Butter.
 O. D. Schultys & Son, Middletown,
 Higganum Creamery Prints, Renovated Prints, Farmers' Butter.
 C. A. Allison, Middletown, Renovated Prints.
 M. J. Cronin, Middletown,
 Renovated Prints, Granby Creamery Prints, York State Creamery Tub.
 L. Rosenwesser, Middletown, Meadow Gold Prints, Farmers' Butter.
 W. J. Trevithick, Middletown,
 Meadow Gold Prints, Gold Medal Prints, Elgin Creamery, Renovated Prints, Rockdale Tub.
 Fred P. Schram, Middletown,
 Blue Grass Prints, York State Tub, Farmers' Butter.
 Russell Bros., New Britain,
 Western Creamery Tub, Renovated Tub, Print Butter from Tub.
 City Market, New Britain,
 Meadow Gold Prints, Renovated Prints, York State Creamery Tub.

Union Tea Co., New Britain,
 Western Creamery Tub, Renovated Tub, Renovated Prints, East
 Canaan Creamery Prints.

Union Supply Co., New Britain,
 Gold Medal Tub, Renovated Tub, Renovated Prints.

J. E. Murphy, New Britain,
 Hartford Dairy Prints, Granby Creamery Prints, York State
 Tub. Dutchess County Prints, Olemargarine.

T. C. Flynn, New Britain,
 Meadow Gold Prints, Fairbury Creamery Tub.

M. Nodloney, New Britain, Renovated Prints.

Joseph P. Sweeney, New Britain,
 Meadow Gold Tub, Gold Medal Prints, Meadow Gold Prints.

P. A. Helensky, New Britain, Renovated Prints.

John Hayes, New Britain,
 Meadow Gold Tub, Brookfield Creamery Prints, Renovated
 Prints.

S. F. Hartney, New Britain, Renovated Prints, Meadow Gold Tub.

W. J. Mulligan, New Britain, Renovated Prints.

A. Gordon, New Britain,
 Gold Medal Prints, Renovated Prints, East Haddam Creamery
 Sweet Prints.

P. F. Curtin, New Britain, Renovated Prints, York State Tub.

M. Welinsky, New Britain, Gold Medal Prints, Renovated Prints.

Leon Protass, New Britain, Gold Medal Prints.

Wray & Co., New Britain, Gold Medal Tub.

Sam Kennedy, New Britain, Gold Medal Prints.

E. Sharp, New Britain, Gold Medal Prints.

Sovereigns Trading Co., New Britain,
 Plainville Creamery Prints, Gold Medal Prints, Fairbury
 Creamery Tub.

H. A. Hall, New Britain,
 East Haddam Prints, Gold Medal Prints, Meadow Gold Prints,
 Plainville Creamery Tub.

Union Trading Co., New Britain, Gold Medal Prints, Renovated Tub.

J. T. Ward, New Britain, Gold Medal Prints, Renovated Prints.

Eugene Glasser & Co., New Britain,
 Green Valley Prints, Gold Medal Tub.

G. H. Sqmlow, New Britain, Gold Medal Prints.

J. P. Kelly, New Britain, Plainville Creamery Prints.

Mrs. S. M. Holcomb, New Britain, Golden Starr Prints.

A. Katz, New Britain, Gold Medal Prints.

- A. Rapp, New Britain,
Cromwell Creamery Prints, Gold Medal Prints, Fairbury Creamery Prints.
- Andrew Schaefer, New Britain,
Brookfield Creamery Prints, Renovated Prints.
- M. O'Connell, New Britain,
Fairbury Creamery Prints, Franklin Co. Prints.
- Isaac Timbrell, New Britain, Gold Medal Prints.
- City Market Co., Meriden,
Fox River Prints, Fairbury Prints, Gold Medal Prints, Meadow Gold Prints, Williamsburg Prints, Gold Medal Tub.
- New England Butter House, Meriden,
Extra Western Creamery Tub, First Western Creamery Tub, Renovated Tub, Ladle Tub.
- M. W. Boothe, Meriden,
Gold Medal Prints, Meadow Gold Prints, Renovated Prints.
- H. F. Rudolph, Meriden,
Gold Medal Prints, Meadow Gold Prints, Gold Medal Tub.
- Henry Behrens, Meriden, Fairbury Creamery Tub.
- Paul Kapitzke, Meriden, Simsbury Creamery Prints, York State Tub.
- Meriden Tea & Coffee Co., Meriden, Western Creamery Tub.
- Fred L. Yale & Son, Meriden,
Mountain Spring Creamery Prints, Meadow Gold Prints, York State Creamery Tub.
- Geo. M. Barnes, Meriden, Granby Creamery Prints.
- E. B. Wallace, Meriden, Meadow Gold Prints.
- Frank E. Yale, Meriden,
Granby Creamery Prints, York State Creamery Tub.
- L. B. Francis, Meriden,
York State Creamery Tub, Rockdale Creamery Prints, Granby Creamery Prints.
- F. C. Bechles, Meriden,
Gold Medal Tub, York State Creamery Tub, Renovated Prints, Gold Medal Prints.
- T. F. McCarthy, Meriden, York State Creamery Tub.
- Mrs. H. Pahl, Meriden, Creamery Tub.
- Norton Bros., Meriden, Elgin Creamery Tub.
- Tony Schoenick, Meriden, Meadow Gold Tub.
- W. H. Newell, Meriden, Gold Medal Prints.
- Mills Bros., Meriden,
Ashton Creamery Prints, Gold Medal Prints, Fairbury Creamery Tub.
- O. Fortin, Meriden, Fancy Gilt Edge Tub.

W. J. Kashman, Meriden, Renovated Prints.
A. Port, Meriden, Sweet Butter.
L. C. Brown, Meriden, Avon Creamery Prints, Gold Medal Tub.
Adam Orr, Meriden, Blue Grass Creamery Prints, Western Creamery Tub.
The Boston Grocery Co., Meriden, Canton Creamery Prints, Gold Medal Prints, Gold Medal Tub.
Russell Bros., Meriden, Western Creamery Tub, Renovated Tub.
James J. Pagnan, Meriden, Gold Medal Prints, Gold Medal Tub.
H. E. Bushnell, Meriden, Andover Creamery Prints, Woodland Creamery Prints, Oleo-margarine.
Fred H. Lewis, Meriden, St. Albans Creamery Prints, York State Creamery Tub.
Freler, Carrier & Quivilan, Meriden, Gold Medal Prints.
McHugh & Ferguson, Meriden, Meadow Gold Tub, Meadow Gold Prints.
Julius Augur, Meriden, Meadow Gold Prints, Gold Medal Prints, Fairbury Creamery Tub.
J. W. Burbridge, Meriden, Meadow Gold Prints.
Peter Carter, Meriden, Fairbury Creamery Prints, Fairbury Creamery Tub.
M. Keegan, Meriden, Fairbury Creamery Tub, Gold Medal Prints.
M. Keating, Meriden, Fairbury Creamery Tub, Gold Medal Prints.
Nelson Delesdernier, Meriden, Rockdale Creamery Prints, Western Creamery Tub.
Wm. Murray, Wallingford, Gold Medal Tub, Gold Medal Prints, Farmers' Butter.
W. R. Steele, Wallingford, Gold Medal Prints.
M. W. Sherwood, Wallingford, Gold Medal Prints, Gold Medal Tub.
A. I. Martin, Wallingford, Page Creamery Prints, Farmers' Butter, Cheshire Creamery Prints, York State Creamery Tub.
J. C. Hall, Wallingford, Helena Creamery Prints.
E. C. Lewis, Wallingford, Gold Medal Prints.
W. C. Post, Wallingford, Gold Medal Tub, Gold Medal Prints, Page Creamery Prints.
L. A. Young, Wallingford, St. Albans Creamery Prints.
S. J. Hall, Wallingford, Gilt Edge Creamery Tub, Canton Creamery Prints.
M. W. Boothe, Wallingford, Gold Medal Prints, Renovated Prints.
Laden Bros., Wallingford, Meadow Gold Tub, Meadow Gold Prints.

F. R. Nobert, Wallingford, Gold Medal Tub, Gold Medal Prints.
 Miner & Bridgett, Wallingford,
 Renovated Prints, Granby Creamery Prints, Elgin Creamery
 Tub.
 E. T. Carter, Wallingford, Renovated Tub, Fairbury Creamery Tub.
 P. Gannan, Wallingford,
 York State Creamery Tub, Cheshire Creamery Prints.
 T. Pagnan, Wallingford, York State Creamery Tub.
 Luby Bros., Wallingford, Renovated Prints.
 F. Guide, Wallingford, Gold Medal Tub.
 B. Markowitz & Co., Wallingford, Gold Medal Prints.
 J. W. Lane, Wallingford,
 Gold Medal Prints, York State Creamery Tub.
 Downey Bros., Wallingford,
 Ashton Creamery Prints, York State Creamery Tub.
 Mike Oros, Wallingford, Renovated Tub, Farmers' Butter.
 W. A. Brow, Wallingford, Gold Medal Prints.
 M. Markowitz, Wallingford, Gold Medal Prints.
 Martin Hubert, Wallingford, Gold Medal Prints.
 J. Novak, Wallingford, Gold Medal Prints.
 Wm. Pichowski, Wallingford, Gold Medal Prints.
 Bristol Beef Co., Wallingford, Gold Medal Prints, Renovated Prints.
 C. A. Lane, Bristol,
 Plainville Creamery Prints, Meadow Clover Prints, Renovated
 Prints.
 Chas. H. Beaudoin, Bristol,
 York State Creamery Tub, Gold Medal Prints.
 John Fiorillo, Bristol, Renovated Prints.
 Joe Dimeo, Bristol, Farmers' Butter, Renovated Prints.
 J. Coverty Bros., Bristol, Fairbury Creamery Prints.
 W. F. Smithwick, Bristol,
 Gold Medal Prints, Fairbury Creamery Prints, Farmers' Butter.
 John E. Edman, Bristol,
 Gold Medal Prints, Canton Creamery Prints, Renovated Prints.
 A. Q. Perkins, Bristol, Brookfield Creamery Prints.
 Geo. S. Reede, Bristol, St. Albans Creamery Prints.
 M. L. Gaylord, Bristol, Goshen Creamery Prints.
 M. E. Garrett, Bristol, Canton Creamery Prints, Meadow Gold Prints.
 C. B. Ives, Bristol, Fairbury Creamery Prints.
 J. H. Glasson, Bristol, Sage Creamery Prints, Gold Medal Prints.
 W. B. Woodruff, Bristol,
 Fairbury Creamery Tub, Fairbury Creamery Prints, Goshen
 Creamery Prints, Renovated Prints.

- L. G. Merick, Bristol,
Vernon Creamery Prints, Renovated Prints, Farmers' Butter.
- D. J. Monahan, Bristol, Berkshire Creamery Prints, Renovated Prints.
- E. T. Tucker, Putnam,
Cloverdale Creamery Prints, Farmers' Prints, Cloverdale Creamery Tub.
- Edward Mullen, Putnam,
W. W. W. W. Creamery Prints, Elliott Creamery Tub, Western Creamery Prints.
- Putnam Market, Putnam, Avondale Creamery Prints.
- W. H. Mansfield, Putnam,
Ellington Creamery Prints, Fox River Creamery Prints, Western Creamery Prints.
- J. H. Geeson, Putnam,
Western Creamery Tub, Renovated Tub, Standard Creamery Prints, W. W. W. W. Creamery Prints, Oleomargarine.
- J. E. Sullivan, Putnam,
Gold Medal Prints, Franklin Co. Prints, Gold Medal Tub.
- W. J. Bartlett, Putnam,
Franklin Co. Prints, Delmonte Prints, Gold Medal Prints, Franklin Co. Tub.
- G. Chaput, Putnam, Salmon River Creamery Tub.
- Edward Valliere, Putnam, Cloverdale Creamery Prints.
- A. N. Law, Putnam,
Thompson Creamery Prints, Brookfield Creamery Prints.
- James Bibault, Putnam, Gold Medal Prints, Gold Medal Tub.
- Duval & Mailhot, Putnam,
Gold Medal Prints, Cloverdale Creamery Prints, Farmers' Butter, Renovated Prints.
- P. M. Leclair, Putnam,
Standard Creamery Tub, Standard Creamery Prints, Renovated Prints, Oleomargarine.
- Jos. Lapalme, Putnam,
Gilt Edge Creamery Tub, Mad River Valley Prints.
- R. Bouthillette, Putnam,
Gold Medal Tub, Bakers' Tub Butter, Oleomargarine.
- G. M. Durand, Putnam,
Cloverdale Creamery Prints, Cloverdale Creamery Tub, Gold Medal Prints, Mad River Prints, Renovated Prints.
- Geo. W. Farley, Putnam,
Cloverdale Creamery Boxes, Brown River Valley Prints, Renovated Prints, Gold Medal Tub, Oleomargarine Prints.
- Putnam Mfg. Co., Putnam,

- Barnette Creamery Prints, St. Albans Creamery Prints, St. Albans Creamery Tub.
- C. W. Bradway & Son., Putnam, Thompson Creamery Prints.
- C. S. Lord, Danielson, Brooklyn Creamery Prints, Meadow Clover Prints.
- A. H. Armington, Danielson, Brooklyn Creamery Prints, Jewett City Prints, XXXX Creamery Prints, XXXX Creamery Tub.
- The James Grocery Co., Danielson, Brooklyn Creamery Prints, Cloverdale Creamery Tub.
- Gallup Bros., Danielson, Brooklyn Creamery Prints, XXXX Creamery Prints, Cloverdale Prints, Arctic Creamery Tub, Renovated Prints.
- Waldo Bros., Danielson, Brooklyn Creamery Prints, Cloverdale Creamery Prints, Cloverdale Creamery Tub.
- W. N. Arnold & Co., Danielson, Brooklyn Creamery Prints, Delmonte Creamery Prints, Delmonte Creamery Tub, WWW Creamery Prints.
- City Market, Danielson, Renovated Prints, Avondale Creamery Prints.
- A. Thetrault & Sons, Danielson, Cloverdale Creamery Prints, Cloverdale Creamery Tub, Mad River Creamery Prints, Brookfield Creamery Tub.
- Danielson Colton Co. Store, Danielson, Brookfield Creamery Tub, Brooklyn Creamery Tub.
- Quinebaug Store, Danielson, Cloverdale Creamery Tub, Brooklyn Creamery Prints, Jewett City Creamery Prints, Mad River Prints, Oleomargarine.
- Wilfred Loisselle, Danielson, Brooklyn Creamery Tub, Brooklyn Creamery Prints.
- Joseph Bodo, Danielson, Brooklyn Creamery Prints, Mad River Creamery Prints, Cloverdale Creamery Tub.
- Jos Potirn, Moosup, Mad River Valley Prints, Mad River Valley Tub, Lakeside Creamery Tub, Lyme Creamery Prints, Blue Ribbon Prints.
- L. Batty & Son, Moosup, Jewett City Prints, Fairbury Creamery Prints.
- Frank Bodo, Jr., Moosup, Mad River Creamery Prints, Lakeside Creamery Tub.
- L. M. Pratte, Moosup, Vermont Creamery Prints, Gold Medal Prints, Gold Medal Tub, Brookfield Creamery Prints, Blue Ribbon Creamery Prints.

- F. W. Daggett, Moosup,
Ft. Jackson Creamery Prints, Mt. Mansfield Creamery Prints,
Renovated Prints, York State Creamery Tub.
- C. D. Salisbury, Moosup, Lyme Creamery Prints, Lyme Creamery Tub.
- A. T. Hill, Moosup, Blue Ribbon Prints.
- H. Trudeau, Moosup,
Mad River Creamery Prints, Mad River Creamery Tub, Renovated Tub.
- J. P. Kingsley & Son, Plainfield,
Jewett City Prints, Brookfield Creamery Prints.
- D. G. Gagnon, Jewett City,
Jewett City Creamery Tub, Jewett City Creamery Prints.
- Dearnely & Clarke, Jewett City,
Jewett City Creamery Prints, W W W W Creamery Prints,
WWWW Creamery Tub, Renovated Prints.
- Finn Brothers, Jewett City,
Jewett City Creamery Prints, Jewett City Creamery Tub.
- Geo. Labonne, Jewett City, Renovated Prints.
- Ashland Store, Jewett City,
Jewett City Prints, Jewett City Tub, York State Creamery Tub.
- A. C. Burdick, Jewett City,
Jewett City Creamery Prints, Jewett City Creamery Tub.
- Johnson Bros., Jewett City,
Jewett City Creamery Prints, Brookfield Creamery Prints.
- F. H. Cavanaugh, Jewett City,
Jewett City Creamery Prints, Jewett City Creamery Tub.
- Wheeler Bros., Norwich, Franklin Co. Tub, Franklin Co. Prints.
- The Mohican Co., Norwich,
York State Dairy Tub, Gold Medal Creamery Tub, Franklin Co.
Creamery Tub, Renovated Tub, Mad River Prints, Gold Medal
Prints, Lawndale Prints.
- Cloverdale Creamery, Norwich,
Vermont Creamery Tub, Cloverdale Creamery Tub, Royal
Worcester Tub, Elgin Creamery Tub, Western Creamery 5-pound
Box, Cloverdale Prints, Royal Worcester Prints.
- Somers Bros., Norwich,
Fox River Creamery Tub, Fox River Creamery Prints, Renovated
Prints.
- Welcome A. Smith, Norwich,
Vermont Creamery Tub, Northfield Creamery Prints, Mad River
Prints.
- S. K. Ames, Norwich,
Vermont Creamery Tub, Oakland Creamery Tub, Renovated
Tub, Renovated Prints, Vermont Prints, Oakland Prints.

- Joseph Connor & Son, Norwich, Gold Medal Prints, Brookfield Prints.
 J. S. Spicer, Norwich,
 Vermont Creamery Tub, Mad River Creamery Prints, Renovated Prints.
- W. H. Cardwell, Norwich,
 XXXX Creamery Prints, Mad River Prints, Brookfield Creamery Prints, Gold Medal Prints, Gold Medal Tub.
- Justin Holden, Norwich,
 Gold Medal Prints, Mad River Prints, Vermont Creamery Tub.
- C. M. McNamara, Norwich,
 Mad River Creamery Prints, Western Creamery 5-pound Boxes.
- Henry Norman, Norwich,
 Franklin County Tub, Mad River Creamery Prints.
- A. T. Otis & Sons, Putnam,
 Jewett City Creamery Prints, Mad River Creamery Prints, Vermont Creamery Tub.
- Thos. Wilson, Norwich,
 Browns River Valley Prints, Brookfield Creamery Prints, Vermont Creamery Tub.
- T. B. Robertson, Norwich, Oleo Found in Bakery
- C. W. Hill & Son, Norwich, Mad River Prints, Renovated Prints.
- J. E. Moore, Norwich,
 Gold Medal Prints, WWWW Creamery Prints, Renovated Prints.
- H. D. Avery, Norwich, Franklin Co. Creamery Tub, Mad River Prints.
- Geo. Lapan, Norwich, Mad River Creamery Prints, Renovated Prints.
- A. J. Senft, Norwich,
 Franklin Co. Creamery Prints, Franklin Co. Creamery Tub, Farmers' Butter, Renovated Tub.
- Andrew W. Denff, Norwich, Franklin County Creamery Tub.
- C. D. Sevin, Norwich, Gold Medal Prints, Hyde Park Creamery Prints.
- H. D. Rallon, Norwich,
 Glover Leaf Creamery Prints, Franklin Co. Creamery Tub, Wapping Creamery Prints.
- R. F. Smith, Norwich,
 Conn. Ag. Col. Prints, Elgin Creamery Tub, Renovated Prints.
- A. F. Grodske, Norwich, Renovated Prints.
- Appley & Jordan, Norwich,
 Franklin Creamery Tub, Lebanon Creamery Prints.
- T. McMahon, Norwich, Mad River Creamery Prints, Renovated Prints.
- E. Tracey, Norwich,
 Lebanon Creamery Prints, Gold Medal Prints, Gold Medal Tub.
- J. P. Burlingame, Norwich,
 WWW Creamery Prints, Vt. Creamery Tub.

- A. Francis & Son, Norwich,
 Lebanon Creamery Prints, Gold Medal Prints, Mad River
 Creamery Prints, Franklin Co. Creamery Tub.
- S. Blinderman, Norwich, Browns River Valley Creamery Prints.
 Valentine Lubert, Greenville, Brookfield Creamer Prints.
 P. H. Either, Greenville,
 Lebanon Creamery Prints, Mad River Creamery Prints, Reno-
 vated Prints.
- James W. Semple, Greenville,
 Renovated Tub, Mad River Creamery Prints, Gold Medal Prints.
- Chas. Erwin, Greenville,
 Brookfield Creamery Prints, Gold Medal Prints, Renovated
 Prints.
- J. O'Brien, Greenville, Mad River Prints.
 T. C. Coughlin, Greenville,
 Gold Medal Prints, Brookfield Creamery Prints.
- M. J. Higgins, Greenville,
 Jewett City Creamery Prints, XXXX Creamery Prints, Gold
 Medal Prints, Gold Medal Tub, Renovated Prints.
- A. B. Main, Greenville,
 Jewett City Prints, Gold Medal Prints, Renovated Prints,
 Franklin Co. Creamery Tub.
- Frank H. Smith, New London, Lebanon Creamery Prints.
 H. A. Whiting, New London, Granby Creamery Prints.
 Mohican Co., New London,
 Elgin Creamery Tub, Vermont Dairy Tub, Renovated Tub, Mad
 River Prints, Browns River Valley Prints, Gold Medal Prints.
- George R. Gray, New London,
 Lebanon Creamery Prints, Franklin Co. Creamery Prints, York
 State Creamery Tub.
- W. H. Slocum, New London,
 Franklin Co. Tub, Franklin Co. Prints, Fairbury Creamery Tub.
- J. M. Miner, New London,
 Fox River Prints, Franklin Co. Prints, Franklin Co. Tub.
- J. B. Neal, New London,
 Brown River Valley Prints, Mad River Valley Prints, Vermont
 Creamery Tub.
- C. E. Rice, New London,
 Fairbury Creamery Tub, Franklin Co. Prints.
- M. Joseph, New London, Mt. Mansfield Prints.
 D. Donovan, New London,
 Meadow Gold Tub, Gold Medal Prints, Meadow Gold Prints,
 Blue Grass Prints.

- A. T. Miner, New London,
Fox River Creamery Prints, Gold Medal Prints, Lebanon Prints,
Gold Medal Tub, Renovated Tub.
- Mrs. E. L. Klein, New London, Franklin Co. Creamery Prints.
- John J. Byrne, New London,
Franklin Co. Creamery Tub, Mad River Valley Prints.
- N. Tinker, New London,
Franklin Co. Creamery Prints, Franklin Co. Creamery Tub.
- Wm. A. Holt, New London,
Franklin Co. Creamery Tub, Lebanon Prints, Bozrah Prints.
- A. Cheeney, New London,
Mad River Valley Prints, Brookfield Prints, Green Valley Prints.
- J. P. Kieley, New London,
Renovated Tub, Starr Creamery Tub, Harvard Creamery Tub,
Harvard Creamery Prints, Starr Prints.
- C. H. Schwaner, New London,
Elgin Creamery Tub, Elgin Creamery Prints, Gold Medal Prints,
Granby Creamery Prints.
- Geo. H. Thomas, New London,
Meadow Gold Tub, Franklin Co. Tub, Brookfield Prints, Leban-
on Creamery Prints, Renovated Tub.
- H. Meadnes, New London,
Gold Medal Prints, Mad River Valley Prints, Bozrah Creamery
Prints, Renovated Prints.
- F. H. Davis & Co., New London,
Renovated Tub, Franklin Co. Tub, Wapping Prints, Mansfield
Creamery Prints.
- L. Christiansen, New London,
Gold Medal Prints, Granby Creamery Tub, Granby Creamery
Prints.
- C. H. Klinck & Son, New London, Gold Medal Prints.
- C. A. Anderson, New London, Elgin Creamery Tub.
- Harrigan Bros., New London, Gold Medal Prints, Gold Medal Tub.
- Thomas J. Kehr, New London,
Franklin Co. Tub, Franklin Co. Prints.
- Wm. Redden, New London,
Renovated Tub, Blue Ribbon Prints, Gold Medal Tub.
- Peabody Bros., New London, Brookfield Creamery Prints.
- Geo. H. Miller, New London, Gold Medal Prints.
- M. M. Thomas, New London, Gold Medal Prints.
- M. W. Dart, New London,
Lebanon Creamery Prints, Gold Medal Tub.
- M. F. Ganey, New London, Franklin Co. Creamery Tub.

- Edward Keefe, New London,
Franklin Co. Creamery Tub, Elgin Creamery Tub, Ellington
Prints.
- Rose Mear, New London, Renovated Prints.
- A. G. Manierre, Poquonnock Bridge,
Franklin Co. Creamery Tub, Franklin Co. Creamery Prints.
- C. F. Rowland, Poquonnock Bridge,
Mansfield Creamery Prints, Franklin Co. Creamery Prints,
Franklin Co. Creamery Tub, Farmers' Butter.
- Coe & Bailey, Groton, Lebanon Creamery Prints, Elgin Creamery Tub.
- C. W. Allyn, Groton, XXXX Elgin Creamery Tub, Gold Medal Prints.
- H. E. Marquardt, Groton, Gold Medal Prints, Vermont Creamery Tub.
- J. F. Bailey, Groton, Browns River Valley Prints.
- W. J. Starr, Prop., Groton,
Renovated Tub, Vt. Creamery Tub, Conn. Ag. Col. Prints.
- M. Schrepfer, Hartford, E. L. C. Creamery Prints.
- Chas. Lenhoff, Hartford,
Simsbury Creamery Prints, Meadow Gold Prints, Renovated
Prints.
- Newton Robertson & Co., Hartford,
Vt. Creamery Tub, Amherst Prints, Wapping Prints, East
Canaan Prints, Meadow Gold Prints, Gold Medal Prints.
- Cottage Market, Hartford, Granby Creamery Prints, Gold Medal Tub.
- Hyman F. Smith, Hartford,
Fancy Elgin Tub, Extra Selected Tub, Wapping Creamery
Prints, East Canaan Creamery Prints, Simsbury 5-pound Boxes,
Gold Medal Prints.
- Stokes Market, Hartford,
Gold Medal Tub, Gold Medal Prints, Brookfield Creamery Tub,
Brookfield Creamery Prints.
- Thos. Muscora, Hartford, Meadow Gold Prints.
- C. J. Derer, Hartford,
Gold Medal Prints, Meadow Gold Tub, Meadow Gold Prints,
Blue Grass Prints, Renovated Prints.
- A. George, Hartford, W. W. Creamery Prints.
- Fred Lentz, Hartford, Meadow Gold Prints.
- Wm. Walters, Hartford,
Meadow Gold Tub, Orange Co. Tub, Elgin Creamery Tub, Ver-
mont Creamery Tub, Windsor Prints, Meadow Gold Prints,
Renovated Prints.
- The Model Market, Hartford,
Granby Creamery Prints, Meadow Gold Prints, Meadow Gold
Tub.

- A. S. Graham, Hartford, E. L. C. Creamery Prints, Granby Prints.
H. W. Heaton, Hartford, Green Valley Prints.
Fleming & Cowara, Hartford,
 York State Creamery Tub, Vermont Creamery Tub, Western
 Creamery Tub, Renovated Tub, Granby Prints.
Cady & Lombard, Hartford,
 Granby Creamery Prints, Western Creamery Tub, Dairy Prints,
 Simsbury Creamery Prints.
T. S. Mather, Hartford,
 Meadow Gold Tub, Renovated Tub, Simsbury Creamery Prints.
W. J. Madigan, Hartford,
 Granby Creamery Prints, E. L. C. Prints, Western Creamery
 Tub, W. W. W. W. Creamery Prints.
W. A. Lyons, Hartford,
 Granby Creamery Prints, Gold Medal Prints, Renovated Prints.
Mat Kline, Hartford, Meadow Gold Prints, Gold Medal Prints.

EXAMINATIONS OF VINEGAR.

No.	Sold for	Dealer	Location	Analyses	
				Acidity	Solids
1	Cider	Mrs. J. Brody	New Haven	4.40	2.89
2	Cider	Morris Kent,	New Haven	4.19	2.66
3	Malt	A. Lander	New Haven	4.49	0.34
4	Malt	J. Cramer	New Haven	4.06	0.28
5	Cider	A. Schmidt	New Haven	4.10	2.79
6	Cider	C. Baun	New Haven	4.28	3.60
7	Malt	M. C. Dingwall	New Haven	4.38	0.42
8	Cider	Alex. Kallyfewsky	New Haven	4.15	0.36
9	Cider	Geo. Dahlmeyer	New Haven	4.02	0.27
10	Cider	Wm. J. O'Keefe	New Haven	4.12	3.08
11	Cider	J. & T. Corey	New Haven	4.05	2.41
12	Cider	F. E. Jewett	New Haven	4.31	2.09
13	Cider	Wray & Co.	New Haven	4.38	0.36
14	Cider	Wray & Co.	New Haven	4.25	0.36
15	Cider	H. M. Fett	New Haven	4.25	2.85
16	Cider	Mautte & Co.	New Haven	4.21	3.57
17	Cider	Geo. E. S. Muller	New Haven	4.52	2.63
18	Cider	S. Marumian	New Haven	3.72	2.62
19	Cider	B. Alper	New Haven	4.23	0.34
20	Cider	Mrs. E. Rasche	New Haven	4.25	3.34
21	Cider	Logan Bros. Co.	New Haven	4.08	1.92
22	Cider	J. B. Sullivan	New Haven	5.64	15.89
23	Cider	M. McPadden	Bridgeport	5.65	1.80
24	Cider	Est. of L. Rome	Bridgeport	4.06	2.21
25	Cider	Jno. Washkellewicz	Bridgeport	4.63	2.21
26	Malt	A. Fraenza	Bridgeport	4.36	0.18
27	Cider	D. J. Kenney	Bridgeport	4.06	0.39
28	Cider	Village Store Co.	Bridgeport	4.71	2.36
29	Cider	Centennial Tea Co.	Bridgeport	4.07	1.99
30	Malt	D. E. McNamara	Bridgeport	4.92	1.82
31	Cider	C. Oppenheim	Bridgeport	3.92	2.83
32	Cider	G. C. & A. L. Stewart	Bridgeport	4.89	1.67
33	Cider	H. Isenberg & Co.	Bridgeport	4.93	2.66
34	Cider	Public Market	Bridgeport	3.66	1.74

No.	Sold for	Dealer	Location	Analyses	
				Acidity	Solids
35	Cider	C. D. Cole	Bridgeport	4.40	2.22
36	Cider	Wm. Chew	Bridgeport	4.78	1.88
37	Cider	G. B. Whitney	Bridgeport	4.96	1.74
38	Cider	I. Oppenheim	Bridgeport	3.85	2.16
39	Cider	J. Goldberger	Bridgeport	3.75	1.51
40	Cider	G. E. Elwood	Bridgeport	4.14	2.53
41	Cider	Vincent Bros.	Bridgeport	3.84	6.47
42	Cider	Penn. Mdse. Co.	Waterbury	4.31	2.32
43	Cider	A. Matarazzo	Waterbury	3.96	0.50
44	Malt	M. Malone	Waterbury	4.15	0.27
45	Cider	J. H. McEvoy	Waterbury	4.16	3.07
46	Cider	D. J. Delaney	Waterbury	3.55	2.84
47	Malt	D. J. Phelan	Waterbury	4.60	2.03
48	Cider	Mary A. Thompson	Waterbury	4.19	3.13
49	Cider	A. Ledare	Waterbury	4.33	2.45
50	Cider	D. Chardeneau	Waterbury	5.48	0.32
51	Cider	Geo. McGregor	Waterbury	4.57	1.92
52	Cider	Jos. Fontin	Waterbury	4.17	2.26
53	Cider	J. B. Archambault	Waterbury	4.08	2.05
54	Malt	M. Blanchette	Waterbury	4.28	0.30
55	Cider	Hewitt Gro. Co.	Waterbury	4.15	1.87
56	Cider	M. Spirt	Waterbury	3.82	2.99
57	Cider	Gouura Bros.	Waterbury	4.30	2.24
58	Cider	K. H. Dixon	Waterbury	4.62	2.06
59	Cider	Jno. W. Burns	Waterbury	4.60	2.19
60	Cider	B. Mattson	Waterbury	4.00	0.48
61	Cider	I. & M. Leavitt	Waterbury	4.17	2.36
62	Cider	C. E. Peck	Waterbury	4.98	2.82
63	Cider	G. M. Brink	Waterbury	4.30	2.14
200	Cider	J. P. Guilfoill	Hartford	3.04	1.53
201	Cider	Dow & Co.	Hartford	4.02	2.21
202	Cider	John Pligard	Hartford	4.63	2.43
203	Cider	P. S. Kennedy	Hartford	2.68	0.23
204	Cider	W. K. Smith	Hartford	3.76	0.99
205	Cider	W. K. Smith	Hartford	4.45	0.11
206	Cider	Model Market	Hartford	4.10	2.20
207	Cider	A. S. Graham	Hartford	3.96	2.10
208	W. Wine	B. Schurlyman	Hartford	4.88	0.68
209	Cider	Avenue Market	Hartford	4.82	0.23
210	Cider	Albany Butter Store	Hartford	4.59	2.00
211	Cider	Cady & Lombard	Hartford	4.00	2.22
212	Cider	F. S. Mather	Hartford	4.06	2.33

No.	Sold for	Dealer	Location	Analyses	
				Acidity	Solids
213	Cider	Wm. A. Lyons	Hartford	4.16	2.11
214	Cider	W. J. Madigan	Hartford	4.30	2.11
215	Cider	Hartford Market	Hartford	4.54	2.05
216	Cider	Allen Bros.	Hartford	3.94	2.14
217	Cider	L. Vogel	Hartford	3.96	1.75
218	Cider	Tillinghast	Hartford	5.22	2.37
219	Cider	C. N. Dodge	Hartford	4.48	1.88
220	Cider	Citizens Grocery Co.	Hartford	4.04	1.71
221	Cider	C. H. Strong	Hartford	4.52	2.07
222	Cider	J. W. Buckley	Hartford	4.10	1.99
223	Cider	J. A. Thompson	Hartford	4.06	2.17
224	Cider	S. Marcus	Hartford		
225	Cider	The Washburn Mkt.	Hartford	4.22	2.22
226	Cider	Cannon & Flanagan	Hartford	3.90	0.31
227	W. Wine	D. F. Burns,	Hartford	3.75	0.40
228	Cider	A. A. Thompson	New Britain	4.90	2.54
229	Cider	J. E. Murphy	New Britain	4.75	2.17
230	Cider	Chas. Korburiou	New Britain	4.35	0.30
231	Cider	F. C. Flynn	New Britain	3.96	2.33
232	Cider	James Savok	New Britain	4.23	2.57
233	Cider	Goffny Bros.	New Britain	2.46	2.18
234	Cider	H. A. Hall	New Britain	4.35	2.47
235	Cider	Soverign Trading Co.	New Britain	4.24	2.85
236	Cider	Union Grocery Co.	New Britain	4.20	2.56
237	Cider	Eugene Glaser	New Britain	4.42	2.16
238	Cider	J. D. Monagan	New Britain	4.02	2.14
239	Cider	J. Merreck	Bristol	4.50	1.91
240	Cider	C. A. Lane	Bristol	3.10	2.56
241	Cider	C. H. Beaudoin	Bristol	4.10	0.36
242	Cider	D. B. Woodruff	Bristol	4.24	2.43
243	Cider	A. Costello	Plainville	2.74	2.03
244	Cider	Frisbee & Heminway	Plainville	4.28	2.89
245	Cider	J. W. Morse	Plainville	4.40	2.48
246	Malt	C. W. Hurd	Plainville	4.24	0.36
247	Cider	Newton Robertson Co.	Hartford	4.40	1.27
248	Cider	Hyman Smith	Hartford	4.01	2.50
249	Cider	Pearl St. Gro. Co.	Hartford	3.87	2.53
250	Cider	J. D. Dillon	Hartford	4.05	2.28
251	Cider	Tucker & Goodwin	Hartford	3.87	0.72
252	Cider	Tucker & Goodwin	Hartford	4.38	2.45
253	Cider	Tucker & Goodwin	Hartford	4.48	2.21
254	Cider	Tucker & Goodwin	Hartford	4.01	1.95

EXAMINATIONS OF MOLASSES.

No.	Name of Dealer	Location	Kind
1	P. H. Daley,	Naugatuck,	Porto Rico.
2	S. L. Moulthrop,	Naugatuck,	Porto Rico.
3	Union Supply Co.,	Naugatuck,	Porto Rico.
4	H. H. Schofield,	Naugatuck,	Porto Rico.
5	H. H. Schofield,	Naugatuck,	New Orleans.
6	W. T. Davis,	Naugatuck,	Porto Rico.
7	W. T. Davis,	Naugatuck,	New Orleans.
8	W. A. Brown,	Naugatuck,	Porto Rico.
9	W. F. Brennan,	Naugatuck,	Porto Rico.
10	H. H. Schofield,	Naugatuck,	Porto Rico.
11	E. E. Dunbar & Co.,	East Derby,	Porto Rico.
12	A. F. Beckwith & Co.,	Derby,	New Orleans.
13	Peoples' Grocery Co.,	Derby,	Porto Rico.
14	Peoples' Grocery Co.,	Derby,	Porto Rico.
15	D. M. Welch & Son,	Derby,	Porto Rico.
16	D. M. Welch & Son,	Derby,	New Orleans.
17	Wray & Co.,	Shelton,	Porto Rico.
18	Wray & Co.,	Shelton,	New Orleans.
19	The Wheeler Co.,	Shelton,	Porto Rico.
20	The Wheeler Co.,	Shelton,	New Orleans.
21	Z. C. Beard,	Shelton,	Porto Rico.
22	Z. C. Beard,	Shelton,	New Orleans.
23	D. Donovan,	Shelton,	Ponce.
24	D. Donovan,	Shelton,	Porto Rico.
25	George F. Cook,	Shelton,	New Orleans.
26	J. L. Ballou,	Derby,	Porto Rico.
27	J. L. Ballou,	Derby,	New Orleans.
28	G. W. Cogswell,	Derby,	New Orleans.
29	T. U. Wentworth,	Ansonia,	Porto Rico.
30	T. U. Wentworth,	Ansonia,	New Orleans.
31	People's Grocery Co.,	Ansonia,	New Orleans.
32	P. W. Fogarty,	Ansonia,	New Orleans.
33	P. W. Fogarty,	Ansonia,	New Orleans.
34	Camp & Rudd Co.,	Seymour,	New Orleans.
35	Camp & Rudd Co.,	Seymour,	Porto Rico.

No.	Name of Dealer	Location	Kind
36	H. O. Chatfield,	Seymour,	New Orleans.
37	H. O. Chatfield,	Seymour,	Porto Rico.
38	P. G. Newton,	Seymour,	New Orleans.
39	H. S. Daskam,	Stamford,	Porto Rico.
40	H. S. Daskam,	Stamford,	New Orleans.
41	S. L. Smallhorn,	Stamford,	New Orleans.
42	P. W. Shea,	Stamford,	Porto Rico.
43	P. W. Shea,	Stamford,	New Orleans.
44	E. O. Lester,	Stamford,	Porto Rico.
45	E. O. Lester,	Stamford,	New Orleans.
46	Empire State Tea Co.,	Stamford,	Porto Rico.
47	Acker, Merrill & Condit,	Stamford,	Porto Rico.
48	O. S. Brown,	Stamford,	Porto Rico.
49	O. S. Brown,	Stamford,	Porto Rico.
50	C. Andersen,	Stamford,	New Orleans.
51	J. M. Wassing,	Stamford,	New Orleans.
52	J. M. Wassing,	Stamford,	Porto Rico.
53	New York Grocery Co.,	South Norwalk,	New Orleans.
54	Lorenzo Dibble,	South Norwalk,	New Orleans.
55	The United Grocery Co.,	South Norwalk,	New Orleans.
56	L. Joseloff,	South Norwalk,	New Orleans.
57	C. Becker & Son,	South Norwalk,	New Orleans.
58	S. Schilefsky,	South Norwalk,	New Orleans.
59	Acker, Merrill & Condit Co.,	Greenwich,	New Orleans.
60	Acker, Merrill & Condit Co.,	Greenwich,	Porto Rico.
61	Eugene Glaser & Co.,	New Britain,	New Orleans.
62	Charles Nothnagle & Son,	New Britain,	Porto Rico.
63	G. H. Sanborn,	New Britain,	Porto Rico.
64	The City Market,	New Britain,	New Orleans.
65	The City Market,	New Britain,	Porto Rico.
66	Thomas C. Flynn,	New Britain,	Porto Rico.
67	John O'Brien,	New Britain,	Porto Rico.
68	J. J. Quilty,	New Britain,	Porto Rico.
69	C. Beers,	Danbury,	New Orleans.
70	C. Beers,	Danbury,	Porto Rico.
71	New York Cash Grocery,	Danbury,	New Orleans.
72	E. W. Ehle,	Danbury,	Dark Molasses.
73	The Danbury Grocery Co.,	Danbury,	New Orleans.
74	The Danbury Grocery Co.,	Danbury,	Porto Rico.
75	Charles H. Bell,	Portland,	New Orleans.
76	Charles H. Bell,	Portland,	Porto Rico.
77	P. Sullivan,	Portland,	Porto Rico.

No.	Name of Dealer	Location	Kind
78	P. Sullivan,	Portland,	Dark Molasses.
79	Middletown Cash Grocery,	Middletown,	Light New Orleans.
80	Middletown Cash Grocery,	Middletown,	Dark New Orleans.
81	A. H. Waterbury,	New Haven,	New Orleans.
82	Logan Brothers,	New Haven,	New Orleans.
83	M. C. Dingwall,	New Haven,	New Orleans.
84	S. S. Adams,	New Haven,	Porto Rico.
85	Kohn Brothers,	New Haven,	Pure Molasses.
86	Wray & Co.,	New Haven,	Porto Rico.
87	Wray & Co.,	New Haven,	New Orleans
88	R. R. Parrott,	Bridgeport,	New Orleans.
89	Logan Brothers,	Bridgeport,	New Orleans.
90	Jesse Lund,	Bridgeport,	New Orleans.
91	Pike Brothers,	bridgeport,	New Orleans.
92	Pike Brothers,	Bridgeport,	Porto Rico.
93	Pike Brothers,	Bridgeport,	Dark Porto Rico.
94	E. W. Oviatt & Co.,	Bridgeport,	New Orleans.
95	E. W. Oviatt,	Bridgeport,	Porto Rico.
96	C. M'Carthy,	Bridgeport,	New Orleans.
97	C. M. Raymond,	Bridgeport,	New Orleans.
98	C. M. Raymond,	Bridgeport,	Porto Rico.
99	G. M. Brink,	Waterbury,	New Orleans.
100	J. H. McEvoy,	Waterbury,	Dark Porto Rico.
101	D. J. Delaney,	Waterbury,	Porto Rico.
102	D. J. Phelan,	Waterbury,	New Orleans.
103	Albert LeClaire,	Waterbury,	Porto Rico.
104	M. W. Sherwood,	Wallingford,	Porto Rico.
105	M. W. Sherwood,	Wallingford,	New Orleans.
106	Laden Brothers,	Wallingford,	Porto Rico.
107	Laden Brothers,	Wallingford,	New Orleans.
108	Miner & Bridgett,	Wallingford,	Porto Rico.
109	J. W. Lane,	Wallingford,	Porto Rico.
110	Boston Grocery Co.,	Meriden,	Cooking Molas.
111	Boston Grocery Co.,	Meriden,	New Orleans.
112	Block & Behrens,	Meriden,	Porto Rico.
113	Block & Behrens,	Meriden,	Porto Rico.
114	M. W. Boothe,	Meriden,	Porto Rico.
115	M. W. Boothe,	Meriden,	New Orleans.
116	McM. Dolet,	Winsted,	Porto Rico.
117	H. C. Price,	Winsted,	Porto Rico.
118	F. A. Stickles,	Torrington,	Porto Rico.
119	G. W. Main,	Torrington,	Porto Rico.

No.	Name of Dealer	Location	Kind
120	G. W. Main,	Torrington,	Light Porto Rico.
121	G. W. Main,	Torrington,	New Orleans.
122	G. H. Thomas,	New London,	Dark New Orleans.
123	G. H. Thomas,	New London,	New Orleans.
124	F. H. Davis & Co.,	New London,	Porto Rico.
125	F. H. Davis & Co.,	New London,	New Orleans.
126	New York Cash Grocery,	New London,	New Orleans.
127	T. J. Kehr,	New London,	New Orleans.
128	William Redding,	New London,	New Orleans.
129	M. W. Dart,	New London,	New Orleans.
130	Edward Keefe,	New London,	New Orleans.
131	George R. Gray,	New London,	New Orleans.
132	J. M. Miner,	New London,	New Orleans.
133	Est. of W. A. Holt,	New London,	New Orleans.
201	E. T. Tucker,	Putnam,	New Orleans.
202	E. T. Tucker,	Putnam,	Porto Rico.
203	Edward Mullen,	Putnam,	Porto Rico.
204	Edward Mullen,	Putnam,	New Orleans.
205	W. H. Mansfield,	Putnam,	New Orleans.
206	W. H. Mansfield,	Putnam,	Porto Rico.
207	George Farley,	Putnam,	Porto Rico.
208	Joseph La Palme,	Putnam,	Porto Rico.
209	Joseph La Palme,	Putnam,	Porto Rico.
210	T. McClellan,	Putnam,	Porto Rico.
212	T. McClellan,	Putnam,	New Orleans.
214	W. J. Bartlett,	Putnam,	Porto Rico.
213	W. J. Bartlett,	Putnam,	New Orleans.
215	J. E. Sullivan,	Putnam,	New Orleans.
216	J. E. Sullivan,	Putnam,	Porto Rico.
217	A. H. Armington,	Danielson,	New Orleans.
218	A. H. Armington,	Danielson,	Porto Rico.
219	Waldo Brothers,	Danielson,	New Orleans.
220	Waldo Brothers,	Danielson,	Porto Rico.
221	The James Grocery Co.,	Danielson,	Porto Rico.
222	The James Grocery Co.,	Danielson,	New Orleans.
223	W. N. Arnold,	Danielson,	New Orleans.
224	W. N. Arnold,	Danielson,	Porto Rico.
225	A. Tetrault & Son,	Danielson,	Porto Rico.
226	A. Tetrault & Son,	Danielson,	New Orleans.
227	A. A. Despress,	Danielson,	Porto Rico.
228	A. A. Despress,	Danielson,	Porto Rico.
229	A. A. Despress,	Danielson,	New Orleans.

No.	Name of Dealer	Location	Kind
230	Quinnebaug Store,	Danielson,	Porto Rico.
231	Quinnebaug Store,	Danielson,	New Orleans.
232	City Grocery Co.,	Willimantic,	Porto Rico.
233	City Grocery Co.,	Willimantic,	New Orleans.
234	A. A. Trudeau,	Willimantic,	New Orleans.
235	A. A. Trudeau,	Willimantic,	Porto Rico.
236	Willimantic Cash Grocery,	Willimantic,	New Orleans.
237	George R. Tripp,	Willimantic,	Porto Rico.
239	George R. Tripp,	Willimantic,	New Orleans.
240	Reade Brothers,	Willimantic,	New Orleans.
241	Reade Brothers,	Willimantic,	Porto Rico.
242	Frank Larrabee,	Willimantic,	New Orleans.
243	Frank Larrabee,	Willimantic,	Porto Rico.
244	Milton Hall,	Willimantic,	New Orleans.
245	Milton Hall,	Willimantic,	Porto Rico.
246	Mullen & St. Onge,	Willimantic,	New Orleans.
247	Mullen & St. Onge,	Willimantic,	Porto Rico.
248	C. R. Hibbard,	Willimantic,	New Orleans.
249	C. R. Hibbard,	Willimantic,	Porto Rico.
250	A. K. Talcott,	Rockville,	New Orleans.
251	A. K. Talcott,	Rockville,	Porto Rico.
252	Ransome Brothers,	Rockville,	New Orleans.
253	Ransome Brothers,	Rockville,	Porto Rico.
254	H. O. Keeney,	Rockville,	New Orleans.
255	H. O. Keeney,	Rockville,	Porto Rico.
256	F. Farrenkoff,	Rockville,	New Orleans.
257	F. Farrenkoff,	Rockville,	Porto Rico.
258	Carlos Doane,	Rockville,	New Orleans.
259	Carlos Doane,	Rockville,	Porto Rico.
260	McNeill & Conway,	Rockville,	New Orleans.
261	McNeill & Conway,	Rockville,	Porto Rico.
262	Eugene Slogan Co.,	New Britain,	New Orleans.
263	New York Cash Grocery,	New London,	New Orleans.

EXAMINATION OF FEED STUFFS.

Location of Dealer	Kind of Feeds Sold	Fat	Protein
Stamford,	Glove Gluten Feed,	2.50	26.00
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Hominy Feed,	No Analysis	
	Oat Feeds—H. O. Horse,	4.50	12.00
	Oat Feeds—H. O. Poultry,	5.50	17.00
	Oat Feeds—H. O. Dairy,	4.50	18.00
	F. S. Stock Feed,	5.00	12-13
	Boss Corn & Oat,	4.00	9.00
	Lucerns,	4.50	13.50
	Cotton Seed Meal,	7-9	41-43
So. Norwalk,	Linseed Meal,	5-7	32-36
	Buffalo Gluten Feed,	3.00	28.00
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Hominy Feed,	7. $\frac{1}{2}$ -9	10-12
	Victor Oat Feed,	4.00	9.00
	N. E. F. S.,	4.00	10.00
	H. O. Horse,	4.50	12.00
	H. O. Dairy,	No Analysis.	
	D. E. Fr.,	3.00	8.30
	H. O. Poultry,	5.50	17.00
	Buffalo Cereal, Horse,	4.50	12.00
	Schucmaker's,	5.00	13.00
	Cotton Seed Meal,	9.00	43.00
Danbury,	Buffalo Gluten,	3.00	25.00
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Paragon Hominy Feed,	7. $\frac{1}{2}$ -9	10. $\frac{1}{2}$ -12
	Quaker Oat Feed,	3.50	14.00
	H. O. Poultry,	5.50	17.00
	Cotton Seed Meal,	9.00	43.00
Danbury,	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Hominy Feed,	7. $\frac{1}{2}$ -9	10-12

Location of Dealer	Kind of Feeds Sold	Fat	Protein
	H. O. Horse,	4.00	12.00
	N. E. Stock,	4.00	9.00
	Exc. Corn & Oat,	4.20	9.00
	Lenox Stock,	3.27	9.38
Derby,	Cotton Seed Meal,	9.00	43.00
	Linseed Meal,	3.00	40.00
	Bay State Gluten,	3.00	26.00
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Victor Oat Feeds,	4.00	9.00
	Jersey Mixed Oat,	3.20	12.05
Shelton	Cotton Seed Meal,	9.00	43.00
	Buffalo Gluten Meal,	3.00	28.00
	Bay State Gluten Meal,	3.00	26.00
	Globe Gluten Feed,	2.60	26.00
	Wheat Middlings,	No Analysis.	
	Royal Mixed,	5.48	18.61
	Wheat Bran,	No Analysis.	
	Victor Oat Feed,	4.00	9.00
Shelton,	Cotton Seed Meal,	9.00	43.00
	Linseed Meal,	5-7	32-36
	Gluten Feed,	No Analysis.	
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Monarch Chop Oat,	4-20	8-13
Bridgeport,	Cotton Seed Meal,	None in stock.	
	Globe Gluten Feed,	2.50	26.00
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Victor,	4.00	9.00
	Quaker Oat Dairy,	3.50	14.00
	Local Provender,	No Analysis.	
	Schumacker's stock,	5.00	13.00
	Lucerne's Horse,	3.50	13.50
	Lucerne's Dairy,	3.50	16.50
Bridgeport,	Green Diamond C. S. Meal,	9.00	43.00
	Linseed Meal,	No Analysis.	
	Buffalo Gluten Feed,	3.00	25.00
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Oat Provender,	No Analysis.	
	Victor,	4.00	9.00

Location of Dealer	Kind of Feeds Sold	Fat	Protein
Bridgeport,	Schumacker's,	5.50	13.50
	Linseed Meal,	3.00	40.00
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Buffalo Cereal Horse,	4.50	12.00
New Haven,	Boss Corn & Oat,	4.00	9.00
	Owl Brand C. S. Meal,	9.00	43.00
	Linseed Meal,	3.00	40.00
	Globe Gluten Feed,	2.50	26.00
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Paynes Malt Sprouts,	Analysis Guaranteed.	
New Haven	Boss,	4.00	9.00
	Buffalo Horse,	4.50	12.00
	Victor,	4.00	9.00
	American L. Co.,	1-3	37-40
	Buffalo,	3.00	27.00
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Victor,	4.00	9.00
	Schumacher's,	5.00	12-13
	Indiana Mixed,	3.20	12.05
Ansonia,	Linseed Meal,	3.00	40.00
	Globe Gluten Feed,	2.50	26.00
	Colonial Middlings,	6%	13½
	Hominy Feed,	No Analysis.	
	Victor Oat,	4.00	9.00
	H. O. Horse,	4.50	12.00
	H. O. Dairy,	4.50	18.00
	H. O. Poultry,	5.50	17.00
	Lucerne Horse,	3.50	13.50
	Lucerne Dairy,	3.50	16.50
	Cotton Seed Meal,	9.00	43.00
	Linseed Meal,	1-3	37-40
	Bay State,	3.00	26.00
Ansonia,	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Victor Oat Feed,	4.00	9.00
	Victor Oat Feed,	4.00	9.00
	Boss,	4.00	9.00
Seymour,	Quaker,	3.50	14.00
	Excelsior,	4.20	9.00

Location of Dealer	Kind of Feeds Sold	Fat	Protein
Waterbury,	American Stock,	5.00	12.13
	Hunters Cotton Seed Meal,	9.00	43.00
	Old Process Linseed Meal,	5-7	32-36
	Warner's Gluten Feed,	3.00	25.00
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Hominy Feed,	No Analysis.	
	H. O. Horse,	4.50	12.00
	New England Stock,	4.00	10.00
	Victor,	4.00	9.00
Waterbury,	Schumacker's Stock,	5.00	13.00
	Linseed Meal,	5.50-8.50	30-35
	Warner's Gluten Feed,	3.00	25.00
	Colonial Middlings,	6%	13½
	Wheat Bran,	No Analysis.	
	Hominy Feed,	7½-9	10-12
	Quaker,	3.50	14.00
	Dickinson Stock,	4.14	10.04
	American Poultry,	4.50	14.00
	Calf Meal,	5.00	25.00
Naugatuck,	Lucerne Dairy,	3.50	16.50
	Cotton Seed Meal,	No Analysis.	
	Gluten Feed,	None in Stock.	
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Blue Ribbon Hominy Feed,	8.00	11.00
	Buckeye Wheat Feed,	4.70	17.75
	Boss Oat Feed,	4.00	9.00
	Victor,	4.00	9.00
	Corn, Oat & Barley,	5.00	13.00
Naugatuck,	Buffalo Cereal Creamery,	5.00	20.00
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Hominy Feed,	No Analysis.	
	Boss Oat,		
	H. O. Horse,	4.50	12.00
	Buffalo Cereal Poultry,	5.00	17.00
	Defi,	3.00	8.50
	Linseed Meal,	No Analysis.	
	Blue Grass Mixed,	3.19	12.59
Winsted,	Linseed Meal,	5-7	30-36
Winsted,	Buffalo Gluten Feed,	3.00	25-28

Location of Dealer	Kind of Feeds Sold	Fat	Protein
Torrington,	Paragon Hominy Feed,	7 1/2-9	10 1/2-12
	Victor,	4.00	9.00
	Hunters C. S. Meal,	9.00	43.00
Torrington,	Linseed Meal,	5.50-8.50	30-35
	Buffalo Gluten,	3.00	25.00
	Buckeye,	4.70	17.75
	Hominy Feed,	8.50	10.50
	Ajax,	12.00	33.00
	Schumacker's,	5.00	12-13
	Victor,	4.00	9.00
	Buffalo Cereal Horse,	4.50	12.00
	Buffalo Cereal Dairy,	5.00	20.00
	Buffalo Cereal Poultry,	5.00	17.00
Portland,	Lucerne,	3.50	16.50
	Linseed Meal,	No Analysis.	
Middletown,	Hominy Feed,	No Analysis.	
	Ga. Cotton Oil Co.,	8.00	38.61
	Globe Gluten Feed,	2.50	26.00
Middletown,	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Hominy Feed,	No Analysis.	
	Buffalo Gluten Feed,	No Analysis.	
	Hominy Feed,	No Analysis.	
Meriden,	Glen Cove Gluten Feed,	No Analysis.	
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Hominy Feed,	No Analysis.	
Meriden,	Linseed Meal,	No Analysis.	
	Buffalo C. Co. Hominy Feed,	8.50	10.50
	Buffalo Horse,	4.50	12.00
	Buffalo Corn & Oat Chop,	4.00	8.00
Wallingford,	Magnolia Cotton Seed Meal,	9.00	43.00
	Buffalo Gluten Feed (bulk),	No Analysis.	
	Paragon Hominy Feed,	7 1/2-9	10 1/2-12
	Victor Oat Feed,	4.00	9.00
Bristol,	Globe Gluten Feed,	No Analysis.	
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	M. Hilliard's Hominy Feed,	7 1/2-9	10-12
	Ajax Flakes,		
	Schumacker's Stock,	5.00	13.00
	H. O. Poultry,	5.50	17.00

Location of Dealer	Kind of Feeds Sold	Fat	Protein
Putnam,	Hunters Cotton Seed Meal,	9.00	43.00
	Linseed Meal,	No Analysis.	
	Buffalo Gluten Feed,	3.00	25.00
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
Putnam,	Hunter's Cotton Seed Meal,	9.00	43.00
	American Linseed Meal,	1-3	37-40
	Buffalo Gluten,	3.00	25.00
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Brewers Grains XXXX,	11.00	33.00
	Provender,	No Analysis.	
Danielson,	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Provender,	No Analysis.	
Moosup,	Wheat Middlings,	No Analysis.	
	Blue Ribbon Hominy Feed,	8.00	11.00
	Union, Brewers Grains,	7.00	24.00
	Green Diamond Horse,	7-9	10-11
	Green Diamond Sugar,	3.05	12.50
	Jersey Mixed,	3.20	12.05
Plainfield,	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Hominy Feed,	No Analysis.	
Jewett City,	American Cotton Seed Meal,	9.00	43.00
	Starr Hominy Feed,	7.31	9.88
	Biler,	7.00	24.00
Jewett City,	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
	Local Provender,		
	Cotton Seed Meal,	9.00	41.00
Norwich,	Old Process Linseed Meal,	5-7	30-36
	Buffalo Horse,	4.50	12.00
	Wheat Middlings,	No Analysis.	
	Wheat Bran,	No Analysis.	
New London,	Hominy Feed,	No Analysis.	
	Buffalo Cereal Horse,	4.50	12.00
	Cream Meal,	3.00	35.50
	Hunter's Hominy Feed,	7.70	11.02
Hartford,	Quaker Dairy,	3.50	14.00

RETURNS FROM EXPERIMENT STATION OF ADULTERATED EXTRACTS.

VANILLA.

Eureka Mfg. Co., Hartford, Conn. Vanilla.

Purchased at Ansonia, 9-10-'04. Contains Artificial Color.

Twentieth Century Ext. Co., Hartford, Conn. Vanilla.

Purchased at Ansonia, 9-10-'04. Contains Coumarin and Artificial Color.

Walsh Bros., Ansonia, Conn. Ext. Vanilla.

Purchased at Ansonia, 9-10-'04. Contains Coumarin and Artificial Color.

Druggists Vial, marked Extract of Vanilla.

Purchased at Bridgeport, 9-10-'04. Contains Coumarin and Artificial Color.

Victor Mfg. Co., Hartford, Conn. Vanilla.

Purchased at Bridgeport, 9-1-'04. Contains Coumarin and Artificial Color.

Twentieth Century Ext. Co., Hartford, Conn. Vanilla.

Purchased at Bridgeport, 9-1-'04. Contains Coumarin and Artificial Color.

Good Value Extra Co., New York. Good Value Ext. Vanilla.

Purchased at Bridgeport, 9-1-'04. Contains Coumarin and Artificial Color.

Druggists' Vial, marked Extract of Vanilla.

Purchased at Bristol, 9-15-'04. Contains Coumarin.

Baldwin & McDonald, Danbury, Conn. Pure Concentrated Ext.

Purchased at Danbury, 9-8-'04. Contains Coumarin and Artificial Color.

Druggists' Vial, marked Extract Vanilla.

Purchased at Hartford, 9-16-'04. Contains Coumarin and Artificial Color.

Aetna Mfg. Co., Hartford, Conn. Vanilla.

Purchased at Hartford, 9-16-'04. Contains Coumarin and Artificial Color.

J. T. Robertson, Hartford, Conn. Robertson's Ext. Vanilla.

Purchased at Hartford, 9-16-'04. Contains Coumarin and Artificial Color.

- H. M. Grant, Meriden, Conn. Elite Brand Conc. Ext. Van.
Purchased at Meriden, 9-12-'04. Contains Coumarin and Artificial Color.
- Druggists' Vial, marked Extract Vanilla.
Purchased at Meriden, 9-12-'04. Contains Coumarin and Artificial Color.
- Union Tea Co., New Britain and Meriden. Superior Vanilla Flavoring.
Purchased at Meriden, 9-12-'04. Contains Coumarin and Artificial Color.
- D. Johnson & Co., Middletown, Conn. Pure Conc. Ex. Van.
Purchased at Middletown, 9-19-'04. Contains Coumarin and Artificial Color.
- J. G. Hedges, Middletown, Conn. Pure Concentrated Van.
Purchased at Middletown, 9-19-'04. Contains Coumarin and Artificial Color.
- New Eng. Tea Co., Middletown, Conn. Vanilla.
Purchased at Middletown, 9-19-'04. Contains Coumarin.
- McKee Medicine Co., Middletown, Conn. Pure Conc. Ext. Vanilla.
Purchased at Middletown, 9-19-'04. Contains Acetanilid.
- Druggists' Vial, marked Extract Vanilla.
Purchased at Naugatuck, 9-19-'04. Contains Coumarin.
- Arcadian Ext. Co., Union City, Conn. Pure Conc. Ex. Vanilla.
Purchased at Naugatuck, 9-19-'04. Contains Coumarin and Coal Tar Coloring.
- Manufacturers' name not given. Marked Pure Conc. Ext. Vanilla.
Purchased at New Britain, 9-12-'04. Contains Coumarin and Coloring.
- C. H. Talcott & Co., Hartford, Conn. Delmonico Vanilla.
Purchased at New Britain. Contains Coumarin.
- Druggists' Vial, marked Extract Vanilla.
Purchased at New Britain, 9-12-'04. Contains Coumarin and Coloring.
- J. E. Murphy, New Britain, Conn. Pure Conc. Ext. of Vanilla.
Purchased at New Britain, 9-12-'04. Contains Coumarin, Acetanilid and Coloring.
- Druggists' Vial, marked Extract Vanilla.
Purchased at New Haven, 8-31-'04. Contains Coumarin and Coloring.
- Frederick Bros., New Haven, Conn. Vanilla.
Purchased at New Haven, 10-29-'04. Contains Coumarin and Coloring.
- Sterling Extract Co., New York City. Sterling Ext. of Vanilla.
Purchased at New Haven, 12-19-'04. Contains Coal Tar Color.

The Carlson Tea & Butter Co., New Haven, Conn. Standard Quality Ext. Vanilla.

Purchased at New Haven, 10-20-'04. Contains Coumarin and Coloring.

H. M. Tower, New Haven. Tower's Conc. Ex. Vanilla.

Purchased at New Haven, 8-30-'04. Contains Coumarin and Coloring.

Nichols & Harris, New London, Conn. Extract Vanilla.

Purchased at New London, 9-14-'04. Contains Coloring.

Chas. M. Taylor, New London, Conn. Lanman's Vanilla.

Purchased at New London, 9-14-'04. Contains Coumarin and Coloring.

Slater Extract Co., Pawtucket, R. I. Conc. Ext. of Vanilla.

Purchased at Norwich, 9-14-'04. Contains Coumarin and Coloring.

Druggists' Vial, marked Extract Vanilla.

Purchased at Putnam, 9-14-'04. Contains Coumarin and Coloring.

Mfgr. not given. Bottle marked Choice Ext. of Vanilla.

Purchased at Stamford, 9-6-'04. Contains Coumarin and Coloring..

Druggists' Vial, marked Extract Vanilla.

Purchased at Stamford, 9-6-'04. Contains Coumarin and Coloring.

Seeman Brothers, New York. Warfield Brand Ext. Vanilla.

Purchased at So. Norwalk, 9-9-'04. Contains Coloring.

Druggists' Vial, marked Extract Vanilla.

Purchased at So. Norwalk, 9-9-'04. Contains Coumarin.

Sage's Laboratory, Torrington, Conn. Sage's Choice No. 1 Ext. Van.

Purchased at Torrington, 9-20-'04. Contains Coumarin.

.....
Premium Brand Vanilla.

Purchased at Waterbury, 9-19-'04. Contains Acetanilid.

Druggists' Vial, marked Extract Vanilla.

Purchased at Waterbury, 9-19-'04. Contains Coloring.

Druggists' Vial, marked Essence Vanilla.

Purchased at Waterbury, 9-19-'04. Contains Coumarin.

Druggists' Vial, marked Extract Vanilla.

Purchased at Williamntic, 9-15-'04. Contains Coloring.

The C. L. Colton Perfume & Ext. Co. Earlville, N. Y. O. K. Van.

Purchased at Winsted, 9-20-'04. Contains Coumarin and Coloring.

Druggists' Vial, marked Extract Vanilla.

Purchased at Winsted, 9-20-'04. Contains Coumarin and Coloring.

Druggists' Vial, marked Extract Vanilla.

Purchased at Bridgeport, 9-21-'05. Contains Coumarin.

Pure Concentrated Ext. of Fruit Flavors. Favorite Ext. Vanilla.

Purchased at Stamford, 9-22-'05. Contains Coumarin and Coloring.

Danbury Grocery Co., Danbury, Conn. Pure Conc. Ext. Vanilla.

Purchased at Danbury, 9-22-'05. Contains Coumarin, Acetanilid and Coloring.

Purchased at Danbury, 9-22-'05. Contains Coumarin.

Union Pacific Tea Co., New York. Sovereign Vanilla Flavoring.

Purchased at Danbury, 9-22-'05. Contains Coumarin and Coloring.

Purchased at Hartford, 9-26-'05. Contains Coumarin and Coloring.

Purchased at New Britain, 9-25-'05. Contains Coumarin and Color.

McKee Medicine Co., Middletown, Conn. Dr. McKee's Conc. Fruit Extracts, Vanilla.

Purchased at New Haven, 9-20-'05. Contains Coumarin and Coloring.

American Tea Co., New Haven, Conn. Centennial Ext. Vanilla.

Purchased at New Haven, 9-20-'05. Contains Coumarin and Coloring.

Purchased at New Haven, 9-20-'05. Contains Coumarin and Coloring.

Chas. M. Taylor & Co., New London, Conn. Conc. Ext. Vanilla.

Purchased at New London, 9-27-'05. Contains Coumarin and Coloring.

Nichols & Harris, New London, Conn. Extract Vanilla.

Purchased at New London, 9-27-'05. Contains Coumarin and Coloring.

Lambert & Lowman, Detroit, Mich. Royal Conc. Ext. Vanilla.

Purchased at Norwich, 9-27-'05. Contains Coumarin and Coloring.

J. E. Murphy, New Britain, Conn. Pure Ext. Vanilla.

Purchased at New Britain, 9-25-'05. Contains Coumarin, Acetanilid and Coloring.

LEMON.

Walsh Bros., Ansonia, Conn. Extract Lemon.

Purchased at Ansonia, 9-17-'04. Deficient in Lemon Oil and Coloring Matter.

Union Pacific Tea Co., New York City. Sovereign Lemon Flavoring.

Purchased at Bridgeport, 9-1-'04. Deficient in Lemon Oil. Contains Coloring.

Druggists' Vial, marked Essence Lemon.

Purchased at Bristol, 9-15-'04. Deficient in Lemon Oil.

C. L. Colton Perfume & Ext. Co., Earlville, N. Y. Superior Ext. Lemon.

Purchased at Bristol, 9-15-'04. Deficient in Lemon Oil.

Sam'l Stuart & Co., Hatford, Conn. Standard Ext. Lemon.

Purchased at Danbury, 9-8-'04. Artificial Color and Lack of Lemon Oil.

Druggists' Vial, marked Extract of Lemon.

Purchased at Derby, 9-17-'04. Lack of Lemon Oil.

J. D. Welch & Co., New Haven. Lemon.

Purchased at Derby, 9-17-'04. Lack of Lemon Oil.

Trumbull & Co., Hartford, Conn. Lemon.

Purchased at Hartford, 9-13-'04. Lack of Lemon Oil.

Druggists' Vial, marked Pure Conc. Ext. Lemon.

Purchased at Middletown, 9-28-'05. .70 per cent. Lemon Oil.

New England Tea Co., Middletown, Conn. Superior Flavoring Exts. Lemon.

Purchased at Middletown, 9-28-'05. Artificial Color. Only a trace of Lemon Oil.

Pierce Mfg. Co., Danielson, Conn. Pure Conc. Ext. Lemon.

Purchased at New Britain, 9-25-'05. Contains only a trace of Lemon Oil.

Star Extract Co., Boston, Mass. Star Brand Lemon.

Purchased at New Haven, 9-20-'05. Artificial Color. .03 per cent. volume Lemon Oil.

Chas. M. Taylor, New London. Lanman's Choice Flavors. Pure Conc. Ext. Lemon.

Purchased at New London, 9-27-'05. 2.60 per cent. by volume Lemon Oil.

.....
Conc. Ext. Lemon.

Purchased at New London, 9-27-'05. .06 per cent. Lemon Oil.

John T. Doyle, New Haven, Conn. Conc. Ext. Lemon.

Purchased at Norwalk, 9-21-'05. .07 per cent. Lemon Oil.

W. A. Legett & Co., New York City. Victoria Brand XXX Lemon.

Purchased at So. Norwalk, 9-21-'05. Artificial Color. .03 per cent. Lemon Oil.

Disco Bros., Norwich, Conn.

Purchased at Norwich, 9-27-'05. .24 per cent. Lemon Oil.

.....
Lemon.

Purchased at Norwich, 9-27-'05. 2.2 per cent. Lemon Oil.

Lambert & Lowman, Detroit, Mich. Royal Brand Conc. Lemon.

Purchased at Norwich, 9-27-'05. Artificial Color. .30 per cent. Lemon Oil.

Durand Extra Co., Milburn, N. J. High Grade Ext. Lemon.

Purchased at Stamford, 9-22-'05. Tumeric Coloring. 3.2 per cent Lemon Oil.

.....
Purchased at Waterbury, 9-29-'05. Foreign Oil, character of Lemon Grass Oil.

R. Sadd Co., Willimantic, Conn. Purity Flavoring Ext.

Artificial Color. .59 per cent. Lemon Oil

Druggists' Vial, marked Essence Lemon.

Purchased at Hartford, 9-16-'04. Lacks Lemon Oil.

Wise Smith & Co., Hartford, Conn. Superior Lemon Flavoring.

Purchased at Hartford, 9-16-'04. Artificially Colored. Lacks Lemon Oil.

Bergquist Bros., Middletown, Conn. Pure Conc. Ext. Lemon.

Purchased at Middletown, 9-16-'04. Lacks Lemon Oil.

D. Johnson & Co., Middletown, Conn. Pure Conc. Ext. Lemon.

Purchased at Middletown, 9-19-'04. Artificially Colored. Deficient in Lemon Oil.

New England Tea Co., Middletown, Conn. Lemon.

Purchased at Middletown, 9-19-'04. Artificially Colored. Deficient in Lemon Oil.

Perfect Extract Co., Hartford, Conn. Perfect Lemon.

Purchased at Middletown, 9-19-'04. Artificially Colored. Deficient in Lemon Oil.,

.....
Pure Conc. Lemon.

Purchased at New Britain, 9-12-'04. Artificially Colored and Deficient in Lemon Oil.

Victor Mfg. Co., Hartford, Conn. Lemon.

Purchased at New Britain, 9-12-'04. Artificially Colored and Deficient in Lemon Oil.

Union Tea Co., New Britain & Meriden. Superior Lemon Flavoring.

Purchased at New Britain, 9-12-'04. Artificially Colored and Deficient in Lemon Oil.

.....
The Union Extract of Lemon.

Purchased at New Haven, 10-29-'04. Artificially Colored. Deficient in Lemon Oil.

J. T. Hillhouse, New Haven. Pure Extract of Lemon.

Purchased at New Haven, 8-30-'04. Lacks Lemon Oil.

F. J. Markle, New Haven. Concentrated Ext. Lemon.

Purchased at New Haven, 8-31-'04. Artificial Color and Deficient in Oil.

The Carlson Tea & Butter Co., New Haven, Conn. Standard Quality Ext. Lemon.

Purchased at New Haven, 10-29-'04. Artificial Color and Deficient in Oil.

H. M. Tower, New Haven, Conn. Towers Conc. Ext. Lemon,

Purchased at New Haven, 8-30-'04. Artificial Color and Deficient in Oil.

Star Extract Co., Boston, Mass. Star Brand Ext. Lemon.

Purchased at New Haven, 8-30-'04. Artificial Color and Deficient in Oil.

Druggists' Vial, marked Extract Lemon.

Purchased at New London, 9-14-'04. Deficient in Oil.

Baker's Extract Co., New York. Baker's Special Ext. Lemon.

Purchased at New London, 9-14-'04. Artificial Color and Deficient in Oil.

Slater Extract Co., Pawtucket, R. I. Conc. Ext. of Lemon.

Purchased at Norwich, 9-14-'04. Deficient in Oil.

J. E. Thompson, New York. Thompson's Triple Ext. Pure Lemon.

Purchased at Norwich, 10-31-'04. Artificial Color and Deficient in Lemon Oil.

The Lee & Osgood Co., Norwich, Conn. Pure Conc. Ext. Lemon.

Purchased at Putnam, 9-14-'04. Deficient in Lemon Oil.

Hart's Ext. of Lemon.

.....
 Purchased at So. Norwalk, 9-9-'04. Artificial Color and Deficient in Lemon Oil.

Chester Mfg. Co., New York. Chester's Extra Fine Ext. Lemon.

Purchased at So. Norwalk, 9-9-'04. Artificial Color and Deficient in Lemon Oil.

J. G. Powers & Co., New York City. 20th Century Conc. Ex. Lemon.

Purchased at So. Norwalk, 9-9-'04. Artificial Color and Deficient in Lemon Oil.

Lambert & Lowman, Detroit, Mich. Royal Brand Conc. Ext. Lemon.

Purchased at Stamford, 9-6-'04. Artificial Color and Deficient in Lemon Oil.

Fitch A. Hoyt, Stamford, Conn. High Grade Lemon.

Purchased at Stamford, 9-6-'04. Deficient in Lemon Oil.

Druggists' Vial, marked Extract of Lemon.

Purchased at Stamford, 9-6-'04. Deficient in Lemon Oil. Artificial Coloring.

The John T. Doyle Co., New Haven, Conn. Pure Conc. Ext. Lemon.

Purchased at Waterbury, 9-19-'04. Deficient in Lemon Oil. Artificial Coloring.

Sage's Laboratory, Torrington, Conn. Choice No. 1 Ext. Lemon.

Purchased at Waterbury, 9-19-'04. Deficient in Lemon Oil. Artificial Coloring.

C. H. Talcott & Co., Hartford, Conn. Delmonico's Lemon.

Purchased at Willimantic, 9-15-'04. Deficient in Lemon Oil. Artificial Coloring.

Druggists' Vial, marked Extract Lemon.

Purchased at Willimantic, 9-15-'04. Deficient in Lemon Oil.

McMonagle & Rogers, Middletown, N. Y. Lemon.

Purchased at Hartford, 10-8-'04. Foreign Oil Present.

The Horton Cato Mfg. Co., Detroit, Mich. Royal Ext. Lemon—High Grade.

Purchased at Hartford, 9-26-'05. .53 per cent. Lemon Oil.

Old Dominion Mfg. Co., Richmond, Va. Old Dominion Ext. Lemon.

Purchased at Bridgeport, 9-21-'05. .35 per cent. Lemon Oil and Artificially Colored

Queen City Mfg. Co., Newburgh, N. Y. Q. C. Conc. Lemon Flavoring.

Purchased at Danbury, 9-22-'05. 0.08 per cent. Lemon Oil.

Danbury Grocery Co., Danbury, Conn. Conc. Lemon Flavoring.

Purchased at Danbury, 9-22-'05. .20 per cent. Lemon Oil.

Returns from the Experiment Station of Adulterated Olive Oil.

Kind	Adulterated with
Olive Oil "Jos. Fitzpatrick," Waterbury.	Cotton Seed Oil.
Olive Oil "West End Drug Store, Waterbury."	Cotton Seed Oil.
Olive Oil "McNamara's Pharmacy, Bridgeport."	Cotton Seed Oil.
Olive Oil "Pure Olive Oil, Nichols & Harris, New London,	Cotton Seed Oil.
Olive Oil "Pure—C. M. Rogers, New London."	Cotton Seed Oil.
Olive Oil "Taylor's Pres. Pharmacy," New London.	Cotton Seed Oil.
Olive Oil "A. L. Reeves & Co., Danielson."	Cotton Seed Oil.
Olive Oil "Wm. J. Madden, Bristol."	Cotton Seed Oil.
Olive Oil "Hull's Corner Drug Store, New Haven."	Cotton Seed Oil.
Olive Oil "Modern Pharmacy, Hartford."	Cotton Seed Oil.
Olive Oil "J. A. Levery, Bridgeport."	Cotton Seed Oil.

Examinations of Cream of Tartar.

Kind	Adulterated with
Cr. Tartar in bulk.	Acid phos. of lime, alum and malze starch.
Cr. Tartar in bulk.	Sulphite of lime and malze starch.
Cr. Tartar in bulk.	Acid phos. of lime and alum.
Cr. Tartar in bulk.	Acid phos. of lime, alum and malze starch.

Examinations of Coffee.

Kind	Adulterated with
Ground Coffee in bulk,	Cereal product and chicory.
Ground Coffee in bulk,	Cereal product, peas and chicory.
Ground Coffee in bulk,	Chicory and pea product.
Ground Coffee in bulk,	Cereal product and chicory.
"Daylight Mocha & Java Blend,"	Chicory.

Returns from Experiment Station of Adulterated Spices

Kind	Adulterated with
Gold Seal Black Pepper,	Below standard, 8.25 per cent. Ash.
Black Pepper,	10.56 per cent. Ash, 4.13 per cent. Sand.
Black Pepper,	10.67 per cent. Ash, 3.50 per cent. Sand.
Black Pepper,	10.59 per cent. Ash, 3.43 per cent. Sand.
Black Pepper,	10.73 per cent. Ash, 3.70 per cent. Sand.
Black Pepper,	Wheat Product, Nut Shells, Cayenne Pepper and other matter.
Black Pepper,	Ground Coffee Hulls, Olive Stones and Cayenne Pepper.
Black Pepper,	Starchy Material.
Black Pepper,	Ground Olive Stones and Cayenne.
Black Pepper,	Ground Olive Stones.
Cayenne,	Maize Product.
Cayenne,	Maize Product and Artificial Color.
White Pepper, "Finest Quality," John S. Mills & Son,	
N. Y. City,	Cereal Product.
White Pepper,	Cassava Product.
White Pepper,	Wheat Product.
White Pepper,	Wheat Product.
Allspice,	Ground Cocoonut Shells.
Mustard,	Wheat Flour.
Mustard, "S. S. Beard & Co.,"	Wheat Flour and Tumeric.
Mustard, "Standard Tea House,"	
Mustard,	Wheat Flour and Tumeric.
Mustard,	Wheat Flour and Tumeric.
Mustard,	Wheat Flour and Tumeric.
Mustard,	Wheat Flour and Tumeric.
Mustard,	Wheat Flour and Tumeric.
Mustard, "Rivkin Bros.,"	Wheat Flour and Maize Product.
Mustard,	Wheat and Cassava Products and Tumeric.

Returns from Experiment Station of Adulterated Lard.

All Found to be Mixtures Containing Cotton Seed Oil.

Sold for	Location
Lard,	Hartford.
Lard,	New Britain.
Lard,	Hartford.
Lard,	Hartford.
Lard,	Hartford.
Lard,	Waterbury.
Lard,	Waterbury.
Lard,	Waterbury.
Lard,	Waterbury.
Lard,	Waterbury.
Lard,	Waterbury.
Lard,	Bridgeport.
Lard,	Bridgeport.
Lard,	So. Norwalk.
Lard,	Stamford.
Lard,	Stamford.
Lard,	Norwalk.
Lard,	New London.
Lard,	New London.
Lard,	Norwich.
Lard,	Putnam.
Lard,	Middletown.
Lard,	New Haven.
Lard,	New Haven.
Lard,	Hartford.
Lard,	Southington.
Lard,	Waterbury.
Lard,	Waterbury.
Lard,	Waterbury.
Lard,	Waterbury.
Lard,	Waterbury.
Lard,	Torrington.
Lard,	Winsted.

EXPENSES.

Salary of Commissioner	\$1,500.00
Office and Traveling expense	1,048.28
Salary of Deputy Commissioner	1,200.00
Traveling expenses of Deputy Commiss'r and cash paid	968.62

CONCLUSION.

We would take this opportunity to extend the thanks of this Department to the officers of the Connecticut Agricultural Experiment Station for the assistance rendered us during the past year. They have always been greatly interested in the cause of pure food and were, at all times, ready to do all that they could for the good of the public in helping the work along.

The administration of all of the provisions of our general pure food law was originally placed in the hands of the Station but now is carried on, jointly, by the Station and this Department. We have always worked together that good results might be accomplished.

We would, also, heartily extend our thanks to the Dairymen's Association, Creamery Association and especially to the Press of the State for the interest they have shown in all of the work of our Department.

We wish to express our appreciation of the many courtesies extended to us by all the Court officers of the State and the great help they have been to us during the year in successfully administering our pure food laws.

Respectfully submitted,

JOHN B. NOBLE,
Dairy Commissioner.

ANNUAL REPORT

OF

Commissioner on Domestic Animals

TO

THE GOVERNOR

For the Year Ended September 30, 1905.

Printed by
Order of the Legislature.

1906
THE SENTINEL PRESS
ANSONIA, CONN.

Publication Approved
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State of Connecticut.

OFFICE OF THE

Commissioner on Domestic Animals

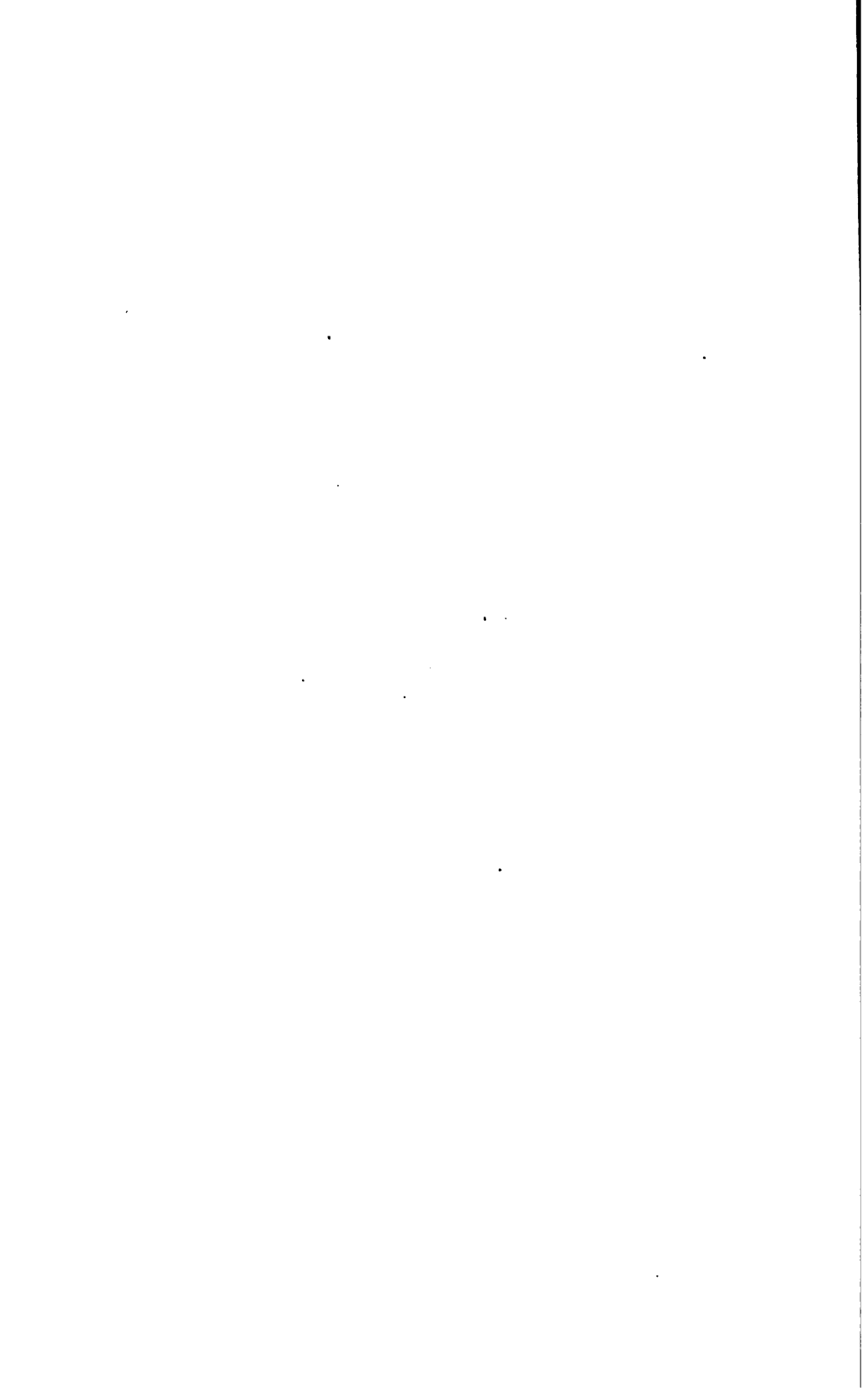
**Room 54, Capitol
HARTFORD.**

TELEPHONE CONNECTIONS:

Hartford Division, 1651. Washington Division, 17-4.

HEMAN O. AVERILL, *Commissioner*
Washington Depot, Conn.

HELEN F. POND, *Clerk and Stenog.*

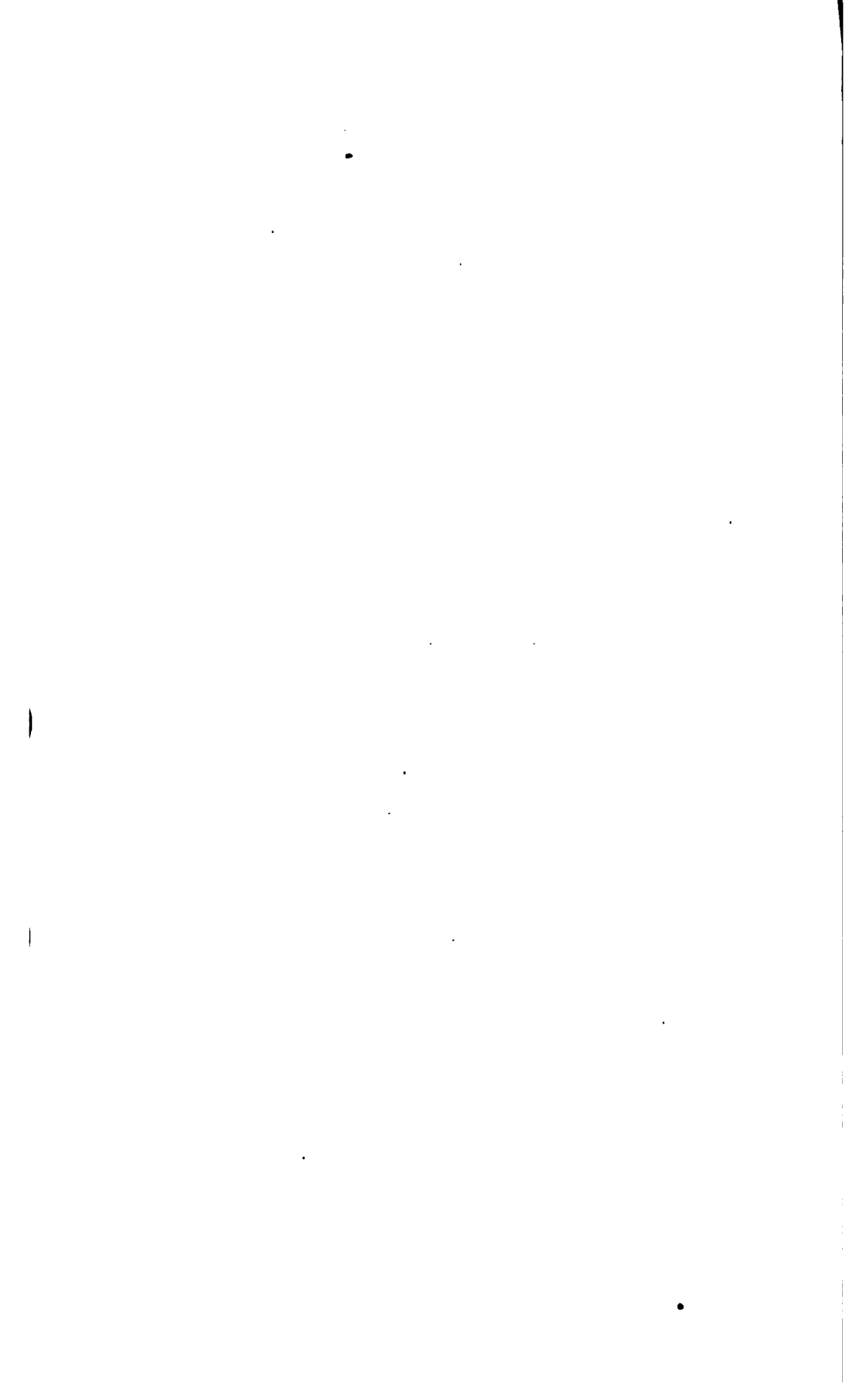


*To His Excellency, Henry Roberts, Governor of the State of
Connecticut:*

SIR: In compliance with the law I have the honor to submit
herewith my report for the fiscal year ending September 30, 1905.

Very respectfully,

HEMAN O. AVERILL,
Commissioner on Domestic Animals.



State of Connecticut.

General Statutes Relating to Domestic Animals

Revision of 1902.

SECTION 4372. The governor shall biennially appoint a commissioner on domestic animals, who shall be a practical farmer and stock breeder of at least ten years' experience. Said commissioner shall hold his office for two years from and after the date of his appointment, and he may, with the approval of the governor, employ such assistants as may be necessary, and any expense so incurred shall be paid by the state upon the approval of the governor. Said commissioner shall annually report to the governor concerning his acts and expenses.

SEC. 4373. When any person shall bring any cattle from an adjoining state into this state he shall, within six days thereafter, notify the commissioner on domestic animals, and such notice shall state the number and sex of such cattle and their actual physical condition. Every person who shall violate any provision of this section shall be fined not more than fifty dollars.

SEC. 4374. Said commissioner may quarantine all animals infected with a contagious disease and prohibit the sale of all the products thereof; but no animal shall be quarantined that does not give evidence of disease upon competent physical examination, and no animal shall be quarantined for more than thirty days.

SEC. 4375. If said commissioner finds that it will be for the good of the state, he may cause said animals so quarantined to be killed, but no animal so quarantined shall be killed until its value has been adjudged by the owner and the commissioner, and if they cannot agree each shall choose a representative who shall choose a third, and the three so chosen shall determine the value of the animal, and the value thus determined shall, when

approved by the commissioner, be paid to said owner by the state upon the order of the comptroller; but no animal whose physical condition indicates that it is of no real value, and no animal that has not been in this state during the six months next prior to its quarantine, shall be paid for by the state. This section shall not apply to horses.

SEC. 4376. The commissioner shall, at the request of the owner of any domestic animal in the state, inspect the same by physical examination, and if he find it free of disease dangerous to the public health he shall so certify to the owner.

SEC. 4377. The selectmen in each town shall report to the commissioner any animals infected with contagious disease.

SEC. 2591. Every person who shall knowingly sell, or expose for sale, milk or any product of milk, from a cow which shall have been adjudged by the commissioner of domestic animals affected with tuberculosis or other blood disease shall be fined not more than seven dollars, or imprisoned not more than thirty days, or both.

RECORDS.

The following is a summary of the records of this department for the year ended September 30, 1905:

Number of calls received to examine cattle,	626
Number of towns from which these calls came,	125
Number of cattle examined in responding to these calls,	3,603
Number of cattle condemned,	487
Average price allowed per head,	\$12.54
Total amount allowed for condemned cattle,	\$6,114.00
Office and traveling expenses,	1,164.06
Veterinarians, services and expenses,	1,231.66
Total,	\$8,509.72

Number of cattle reported to this office as having been brought into Connecticut during the year ending September 30, 1905:

MONTH.	Cows	Heifers	Oxen	Steers	Bulls	Calves	Total
October, . . .	206	86	93	64	75	176	700
November, . . .	258	46	4	64	26	120	518
December, . . .	141	12	4	42	6	31	236
January, . . .	29	54		22	1	4	110
February, . . .	5	36	8	35	1	16	101
March, . . .	5	23	12	16	2	77	135
April, . . .	261	134	26	143	13	180	757
May, . . .	145	204	3	72	13	143	580
June, . . .	152	41		64	8	189	454
July, . . .	258	128		112	32	282	812
August, . . .	231	76	3	25	9	60	404
September, . .	137	64		33	21	16	271
	1828	904	153	692	207	1294	5078

SUMMARY OF YEAR'S WORK.

The following table shows the number of calls received, the number of cattle examined, the number condemned and the total amount allowed for cattle during each month of the fiscal year :

Month	Calls received	Cattle examined	Number condemned	Total allowed
October,	51	213	43	\$508.00
November,	60	193	46	523.00
December,	43	254	37	459.00
January,	45	455	48	625.00
February,	39	356	27	331.50
March,	65	467	53	642.00
April,	67	387	59	848.50
May,	72	420	42	553.50
June,	68	452	34	423.00
July,	25	77	12	140.00
August,	47	166	40	492.00
September,	44	167	46	568.50
Totals,	626	3,603	487	\$6,114.00

Number of cattle condemned each month during each of the past six fiscal years, ending respectively Sept. 30th :

Year ending	1900	1901	1902	1903	1904	1905
October,	9	21	11	18	40	43
November,	9	22	17	21	35	46
December,	8	24	28	28	44	37
January,	11	11	12	24	31	48
February,	3	9	9	19	31	27
March,	9	22	21	26	43	53
April,	5	24	14	29	31	59
May,	15	13	28	22	32	42
June,	11	28	17	16	20	34
July,	19	13	16	21	18	12
August,	12	24	22	23	24	40
September,	7	6	20	35	30	46
Totals,	118	217	215	282	379	487

LOCALITIES.

Number of towns in each county from which calls to examine cattle have been received during each of the past six fiscal years ending respectively September 30:

County	1900	1901	1902	1903	1904	1905
Hartford,	12	18	21	19	22	23
New Haven,	8	11	8	13	13	12
New London,	9	13	17	19	18	19
Fairfield,	7	11	8	12	16	17
Windham,	9	13	14	14	14	13
Litchfield,	13	8	17	18	22	19
Middlesex,	8	8	8	11	9	11
Tolland,	5	9	6	11	10	11
Totals,	71	91	99	117	124	125

During the past six years calls to examine cattle have been received from 161 of the 168 towns in the state.

Number of cattle condemned in each county during each of the past six fiscal years, ending respectively Sept. 30th:

County	1900	1901	1902	1903	1904	1905
Hartford,	20	32	26	16	49	74
New Haven,	12	6	8	22	17	22
New London,	9	56	40	57	85	116
Fairfield,	7	16	5	6	11	13
Windham,	18	40	74	85	105	119
Litchfield,	34	32	34	39	53	78
Middlesex,	9	12	17	31	33	34
Tolland,	9	23	11	26	26	31
Totals,	118	217	215	282	379	487

If the size of the counties and the number of neat cattle kept in each county are taken into consideration it will be seen that no county by reason of locality can claim any appreciable freedom from bovine tuberculosis.

APPRAISALS.

The question of appraising condemned cattle is at best a somewhat perplexing one. On the one hand the owner realizes, as is very often the case that the affected animal is a young cow that has recently dropped a calf; that the past year she had proven herself the most profitable cow in the herd and he had high hopes that she would do even better the coming year. Until after she freshened he probably never had a thought but what she was perfectly healthy and worth \$65.00 just as truly as one dollar is worth another. He soon notices a cough and although her appetite is good and she yields a quantity of milk which meets his expectations, he discovers, ere long, that she is losing flesh and a little corn meal is added to her grain allowance to keep her in condition, but no good results follow. The scales show that she is slowly but surely shrinking in her flow of milk; her cough increases and the loss of flesh becomes more apparent.

The owner, not knowing the cause of the trouble, talks with his neighbors regarding the case and is advised by one who has perhaps had an experience along similar lines, to write to the Commissioner and have her examined.

In response to this request the cow is examined and found to be affected with tuberculosis. The owner is so informed and requested to name a sum which he thinks the State should give him to recompense him for having the cow killed and the carcass buried or destroyed. He is advised that he will be permitted to remove and sell the hide.

Is it not most natural that the owner should think of this young cow, of her record during the past year and of the good quantity of milk she is giving at the time of examination and is it not human nature that he should recite these facts in glowing terms to the examiner?

How differently the case appeals to the Commissioner! He realizes that the animal is affected with an incurable, contagious disease; that the disease has reached a stage when it is developing rapidly and would probably terminate fatally in a few months at most; that the flesh and the milk from the cow are unclean and totally unfit for human consumption if not dangerous to human

life as well as unwholesome for even dogs and poultry; that the presence of that animal in the herd is a menace to the health of every one of its mates and possibly to every member of its owner's family who care for it or frequent the stable where it is confined and breathe the air set in motion by the moving of hay or the sweeping of the manger contaminated by the diseased animal.

He realizes all this and feels that he would truly be doing the owner a favor by ordering the animal removed at once, killed and buried without any compensation for the loss, and if the owner should remonstrate he could inform him that the diseased animal was a curse to him and a source of danger to the community and that to pay him for her would in reality be charity, for it would be giving something for nothing, as the cow has no intrinsic value excepting its hide, which he is at liberty to remove and sell.

The foregoing are the extreme views of the selfish owner and the thoughtless consumer. The framers of the present law in their wisdom undoubtedly favored neither extreme and it has been the policy of this department, since the passage of the law to pursue a conservative policy.

It is but fair to the farmers and cattle owners of the state, with whom the Commissioner has had official relations, either personally or through an assistant, in the matter of appraising condemned cattle, to say that a very large majority of them approach the subject in all fairness. Many, if not most of them, tell the Commissioner to allow them what he thinks is fair and right; with a side remark that if the animal is affected they want to get it out of the herd at once.

In exceptional cases the owner names a price far in excess of what the animal would be worth were it not diseased. The Commissioner pleads guilty to possessing not less than the average amount of human nature and it is quite possible that he has occasionally followed the David Harum Golden Rule, "Do unto the other feller the way he'd like to do unto you—and do it fust," but as a rule the law has not been interpreted as intending the payment of as small an amount as possible by the State for each condemned animal. It has been the honest aim of the commissioner to see that the prices allowed should be as nearly uniform

as it is possible to make them, taking into consideration the apparent condition and appearance of the animal at the time of the appraisal.

During the past year 33 cows have been appraised at \$5.00 per head or less, and we are free to admit that it was more than they were worth.

In 1899, in response to an inquiry as to whether or not the decision of a commissioner (under Sec. 4375), that an animal was of no value, would be final, or would cause a disagreement between the owner and commissioner in the case that the owner thought otherwise, the Attorney General gave, in writing, the following: "I am of the opinion that if there is a disagreement between the owner and the commissioner as to the worth of the animal, that question should be settled by the judgment of the appraisers. Whether an animal possess no value is as much a question of fact as whether the animal possess little or great value."

With this opinion before us, which we believe is as good law, as it is good common sense, it follows that if the owner and the commissioner should disagree in regard to whether an animal has any value, arbitrators would have to be appointed and the State would have to pay the cost of arbitration, the extra traveling expenses of the commissioner caused by the delay and the award of the appraisers, if any.

It will readily be seen that the attendant expense, even if nothing should be awarded, would be more than double the few dollars which would be acceptable to the owner if cheerfully offered in the first place.

It has seemed best, therefore, for the commissioner to cheerfully allow a small amount for these physical wrecks and thus leave the owner in a frame of mind that would prompt him in the future to report any case which he might have or which might come before his notice rather than to have them sold to a dealer and eventually made into bologna sausage.

The commissioner feels justified in asserting in the most positive manner possible that the prices allowed for condemned cattle have not been so large as to tempt dealers to pick up such stock



See page 15

Fig. 1



Fig. 2

See page 15





Fig. 3

See page 15

and then look to this office as a profitable market in which to dispose of them.

During the past year there have been condemned and killed twenty-four pure blooded animals that showed no physical indications of disease except to the expert examiner. Also twelve oxen. The average amount allowed for the thirty-six head was \$26.71, and in every case the owners were, apparently, satisfied although it is quite probable that these same animals could have been sold by their owners in the markets, at the time they were condemned for double the price received for them.

The owner of two cows, not pure bloods and not more valuable than these referred to above, took photographs of them after they were condemned and cuts of them are submitted herewith, together with a photograph of the lungs of the dark colored cow.

By a careful examination of the latter illustration it will be seen that the two largest tubercles have been cut with a knife and that pus is escaping. The lighter colored cow was more generally affected even than the dark one, but the diseased tissue could not be photographed to good advantage.

Neither of these cows were affected with a cough and were both fresh in milk and apparently in perfect condition, as will be seen from the photographs.

The owner received \$25.00 apiece for these cows and was satisfied, although he might have realized double that amount had he cared to sell them to a dealer, no questions asked.

The public can purchase milk or cream from such men with a feeling of satisfaction that they are receiving a good, pure and wholesome product.

SIX YEARS' WORK COMPARED.

The following table shows the number of cattle condemned, the total amount allowed for same and the average price per head during each of the past six fiscal years, also the average expense per animal killed, including office and traveling expenses and veterinarians' services and expenses:

Year ended Sept. 30	Condemned	Total allowed	Average per head	Expense per animal killed
1900,	118	\$1,802.00	\$15.27	\$9.40
1901,	217	3,294.50	15.18	6.29
1902,	215	2,851.50	13.26	5.78
1903,	282	3,797.50	13.47	7.16
1904,	379	4,936.00	12.96	5.77
1905,	483	6,070.00	12.56	4.96

The table shows that the number condemned during the past year was more than four times as many as were condemned the year that ended Sept. 30, 1900. It will be noticed, however, that the steady increase in the work of this department is not owing to any increase in the price paid for cattle, as the average price allowed per head has been lowered almost without exception year by year during the six years given.

The increased average expense, as shown by the table, per animal killed during the year that ended Sept. 30, 1903, was owing to the unusual expense incurred by this department incident to the foot and mouth disease that was epidemic that year in several localities in the neighboring states of Massachusetts and Rhode Island, dangerously near our border lines.

The following table gives the number of cattle examined during each of the past six years, also the number condemned and the percentage of those that were examined that have been found tuberculous and condemned:

Year ended Sept. 30	Number examined	Number condemned	Percentage
1900,	385	118	.306
1901,	825	217	.262
1902,	1,127	215	.190
1903,	1,606	282	.175
1904,	2,581	379	.142
1905,	3,603	487	.135

It should be borne in mind that the above table is not more truly an indication of the prevalence of bovine tuberculosis in the state than would be a comparison of the number condemned with the total number of cattle in the state, but it does go far to dis-

prove any claim that might be made that the disease is rapidly increasing in the state.

The great increase in the work of the department and the lowering of the percentage of animals examined that are condemned, as indicated by the table, would seem to clearly and strongly support the position of the commissioner in his last annual report when he said:

"The calls received by the commissioner to examine suspicious cases of bovine tuberculosis have steadily and rapidly increased since the present law was enacted in 1897. This is clearly an indication that cattle owners are coming to realize more and more that the disease is contagious and that one animal having the disease in an advanced form in a herd of cows endangers the health and well-being of its herd-mates and threatens to wipe out the profits of the herd.

"Farmers are watching their herds more closely than they have in the past, and when they notice the first suspicious symptom of the dread disease they consider it in the light of a danger signal, and recognizing that the state is willing and anxious to aid them in eradicating the trouble, they report their cases to this office and ask to have their herds examined."

DISINFECTION.

The law does not give the commissioner any authority to order the cleaning or disinfection of a stable or even manger after the removal of its tuberculous occupant. It has been the aim of the commissioner to impress as strongly as possibly upon the owner the fact that the manger lately occupied by a tuberculous animal is almost sure to be contaminated and that a healthy animal would very likely contract the disease if permitted to occupy the stall and eat from the manger before the same had been thoroughly cleaned and disinfected.

The first step to be taken in such a case would be to carefully remove and burn all litter and dirt. Then the surface to be disinfected should be thoroughly scraped so that the disinfectant shall be applied directly to the clean surface of the stall and manger.

It matters not so much what kind of disinfectant is used as it does whether the work of preparation and application be thoroughly done.

The one great fault we have to find with the cow-stables throughout the state is that they are too dark. A dark stable is frequently damp and almost always dirty.

Darkness, dampness and filth create a most unfavorable environment for promoting the healthfulness and productiveness of the cow, but combined they furnish ideal conditions for the multiplication and development of the germs of tuberculosis.

Sunlight is a great germ-killer and purifier and many dark, damp stables that are now veritable breeding places of disease germs could easily and cheaply be made light and dry by putting in a few windows and whitewashing the walls and ceilings.

There is no known way in which the expenditure of a very little money can be made to do so much for the comfort and health of a herd of cows and at the same time add to the pride and prosperity of their owner as in the purchase of lime for whitewash for the stable.

All dirt and filth should first be removed from the walls and ceilings by sweeping and scraping if necessary.

The best, as it is the quickest, way to apply whitewash or any other disinfectant is with the spray pump.

SYMPTOMS OF BOVINE TUBERCULOSIS.

Tuberculosis is an insidious disease, frequently existing even in the advanced stages without marked or pronounced symptoms by means of which its presence in the animal can be surely diagnosed.

There are, however, certain conditions and symptoms that the careful and observing caretaker or owner should look upon with suspicion as fingerboards pointing towards tuberculosis. The symptoms which are most likely to be noticed are as follows:

Chronic cough, general unthriftiness, rapid or labored breathing, chronic diarrhoea, tumors in the throat or udder, swelled joints, coughing after vigorous exercise and emaciation.

When one or more of the above symptoms are noticed in any

animal the owner should at once have his herd examined by a veterinarian or report the case to the commissioner.

If owners would practice listening to the lung sounds in their cows, they would frequently be able to discover tuberculous animals. By practicing on healthy cows and then on the suspicious one they may be able to detect a variation in the sounds that will disclose to them the presence of a diseased condition.

Six Good Rules For Dairymen To Follow:

Admit as much sunlight as possible into the stable.

Whitewash the walls, ceilings, and stanchions at least once every year.

Use common sense about turning cows out from a warm barn to stay out in inclement weather.

Make every cow in the herd occupy the same stall every time.

Cleanse and disinfect thoroughly after removing a tuberculous animal.

When you discover symptoms of tuberculosis in any animal in your herd promptly call a veterinarian or report the case to the commissioner and have the animal examined.

CALL NO. 164.

On Jan. 9th, 1905, a telephone notice was received from the office of the Connecticut Humane Society that a herd of cattle at Warehouse Point, owned by a man who lived in West Hartford, included several animals that were apparently diseased. The following day the commissioner, accompanied by Dr. R. P. Lyman, of Hartford, visited the place and examined the whole herd.

The conditions found in the barn were too filthy and disgusting to be adequately described.

The stock, consisting of sixty cows, five bulls and two oxen, were found in two long rows in a cheaply constructed building that had evidently been originally built for a tobacco shed.

They were being fed largely on semi-liquid distillery waste which was drawn to the end of the building in a large tank on

wheels. From this tank the waste was allowed to run through a movable spout into long wooden troughs built in front of the cattle. In these troughs were small gates which could be opened to allow the swill to run into the mangers for the cattle to eat and drink.

As there was so much liquid in the distillery waste it was not thought necessary by the manager to let the animals out to get water, so they were denied even the privilege of getting a few breaths of fresh air every day at watering time. In fact, no facilities for watering cattle were noticed about the place.

The mangers, which were licked clean by the hungry animals, and the troughs in front of them were foul, sour and ill smelling.

Holes were cut through the floor planks here and there to allow a portion of the filth of the stable to run through and soak into the earth below. Owing to the conditions that prevailed in the barn the cows were covered with filth from heads to feet.

Five cows were condemned, appraised, killed, covered with kerosene and buried.

The milk drawn the preceding evening and that morning stood in open receptacles in the stable by the side of the cows, waiting to be shipped to the city that afternoon.

In the end of the stable, partially partitioned off from the cattle, was a room used for slaughtering cattle and storing the carcasses. Several quarters of "beef" were found hanging in this apartment. Their appearance clearly indicated that the animals from which they were taken must have been in the last stages of emaciation. The beef had been cleverly trimmed, but a careful examination showed unmistakable evidence of tuberculosis.

As the commissioner had no authority under the law to condemn the meat, he immediately notified the local town health officer, who pronounced it unfit for food, and ordered it buried.

City Milk Inspector Roberts, of Hartford, was also notified in regard to the place and conditions found there, and he immediately took steps to prevent any more milk from that place being shipped to Hartford.

Soon after this the place changed hands and no further complaints have been heard.

MALIGNANT CATARRH OR INFECTIOUS CATARRHAL FEVER.

During the year there have been reported to this office two cases of mysterious deaths of cows. These cases were carefully investigated by the commissioner.

In each case the owner suspected, or rather, feared poisoning, although no motive or excuse for malicious poisoning could be found to surround either case.

The deaths occurred in March in sections of the state so widely separated that no connection between them could be considered for a moment.

Two cows that had died were post-mortemed and the trouble was diagnosed as malignant catarrh or infectious catarrhal fever.

The cows that were visibly affected were too far gone to respond to treatment and soon died.

As a measure of precaution it was recommended that a generous purge be administered to each cow in the herd. The temperature of every cow was taken and one was found with an elevation to 104 degrees. On the following day this cow exhibited visible symptoms similar to the earlier cases. This cow, owing to the early treatment, made a good recovery.

The stables were thoroughly cleaned and disinfected and no further cases appeared.

As this disease was treated at length in our last report by Dr. E. H. Lehnert, professor of veterinary science at the Connecticut Agricultural College, the symptoms, treatment, etc., are not given here.

It is well to say in passing, however, that the malady very rarely makes its appearance in cows kept in clean, light, dry and well ventilated stables.

SILAGE NOT A SAFE FEED FOR HORSES.

March 4th word was received that a farmer had lost four horses within a short time by death, after being affected but a short time. As the neighbors were fearful of a contagious disease or of poisoning, a veterinarian was deputized by the com-

missioner to examine into the case. Accordingly the following day he visited the farm and made as careful an investigation of the conditions appertaining to the case as possible.

A partial post-mortem examination of the frozen carcasses of two horses was made. While the examination was not very satisfactory, no evidence of poisoning was found and the veterinarian gave it as his opinion that the deaths were caused by forage poisoning, or so-called cerebro-spinal meningitis, produced by eating damaged or moldy silage.

While silage is to be recommended as a very economical and satisfactory feed for cows, it is not considered a safe feed to give horses.

GLANDERS AND FARCY.

The last General Assembly passed an act entitled, "An Act Concerning the Suppression of Glanders and Farcy," and placed its execution on this department.

As this law did not take effect until August 15th, there is very little to report as to the work accomplished; but, sixteen horses affected with glanders or farcy have been destroyed and the stalls and mangers contaminated by them have been torn out and burned or thoroughly disinfected.

In two instances where it was known that glandered horses had drunk at public watering tanks, the tanks have been emptied, thoroughly disinfected, and allowed to remain dry for a short time.

Copies of the following circular containing the law relating to the suppression of glanders and the act providing for a penalty for sale, use or exposure of glandered horses, have been mailed to county, city and town health officers—to the officers and agents of the Connecticut Humane Society, and to veterinarians:

The terms glanders and farcy are recognized in this communication as applying to different types of one and the same disease.

Glanders is a contagious disease readily intercommunicable between the human, the horse, the ass, the mule, the dog, the cat, the rabbit, and the guinea pig. Cattle, swine, and poultry

are immune. When the human becomes inoculated with the disease it usually assumes the acute form and is regarded as a uniformly fatal malady.

Glanders may be transmitted directly from one animal to another, or it may be transmitted indirectly by infected mangers, stalls, feed, stable utensils, harnesses, wagon-poles, and neck-yokes.

SYMPTOMS.

The symptoms of glanders may be divided into two classes, the clinical or prominent symptoms and those that are hidden. Some of the prominent symptoms are as follows: discharge of a dirty white mucus from one or both nostrils. Later on the discharge becomes gray or greenish yellow, frequently streaked with blood and with a tendency to adhere to the nostrils.

Nodules and ulcers may be found on the lining of the nostrils; they have hard, elevated, precipitous borders, and their base is a yellowish white color. Where they have healed a characteristic star-shaped scar is left.

A third clinical symptom is the enlargement of the glands at the angle of the jaw.

In certain forms of the disease there is swelling of limbs, belly, chest, and joints. Small nodules or boils, called farcy buttons, are frequently found on the limbs, shoulders, breast, and belly. They usually ulcerate and discharge a sticky discolored liquid.

When an affected horse is underfed and overworked the disease is likely to develop rapidly, but with good care and feed and only light work to do, such an animal may live indefinitely and not show any physical signs of the disease.

DISINFECTION.

Immediate destruction and deep burial of all animals showing clinical signs of glanders should be the policy of the state and a partial quarantine of any horse that has been exposed to the disease by intimate association with a diseased animal. This should be followed by a thorough disinfection, or better still,

the destruction by fire of manger and stall that has been occupied by a glandered horse, and of all stable utensils, wagon-poles, shafts, neck-yokes, halters, bridles or harnesses that have been exposed to the contagion.

The glanders microbe is killed by a 5 minutes' exposure to a 5 per cent. solution of carbolic acid or creolin or a 1-750 solution of corrosive sublimate. As the germ retains its virulence in the filth of the stable for several months it is important that the stall and manger should be thoroughly scraped and cleaned before being disinfected, and the scrapings burned or buried. The most satisfactory way to apply the disinfectant is with a spray pump, as the solution is then forced into every crack and crevice.

It is not known how prevalent the disease is in this state as the law has not heretofore made it the duty of any one to report cases that have come to their knowledge.

The execution of the new law relating to the suppression of glanders after August 15, 1905, is placed in the hands of the commissioner on domestic animals, who earnestly solicits the hearty co-operation of all veterinary surgeons, health officers, liverymen, and all owners of horses in an earnest effort to ascertain as accurately as possible the localities where disease exists and the number of affected animals in the state.

It is the legal and moral duty of every person in the state to report to the local health officer and to the commissioner on domestic animals every suspected case of glanders that may come to their knowledge, and every person who so reports in good faith may do so with a full assurance that the source of the information will not be made public by this office.

It is not the intention of the commissioner to inaugurate any radical measures for the suppression of glanders or to resort to any unnecessarily rigid or arbitrary quarantine of exposed animals, but rather to pursue as conservative a policy as the seriousness of the malady and the spirit of the law will justify.

[Substitute for House Bill No. 214.]

CHAPTER 257.

An Act concerning the Suppression of Glanders and Farcy.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. For the purpose of preserving the public health, and to prevent the spread of glanders and farcy, the commissioner on domestic animals shall from time to time make orders and regulations relative to the examination, quarantine, and disposal of such animals as are infected with either of the aforesaid diseases, as hereinafter provided.

SEC. 2. The board of health of any city, the selectmen of any town, any officer or agent of the Connecticut humane society, any veterinary surgeon, or any other person having knowledge of or reason to suspect the existence of glanders or farcy in this state, whether such knowledge be obtained by personal examination or otherwise, shall immediately give notice thereof to the commissioner on domestic animals, and to the health officer of the town, city, or borough in which such suspected case exists, and said health officer may immediately quarantine such animal or animals until examined by the said commissioner, but not for a period exceeding ten days. Any person having knowledge of the existence of glanders or farcy who fails to give such notice to the commissioner shall be fined not more than fifty dollars. Upon receipt of such notice the commissioner or his assistant shall examine or cause to be examined the diseased or suspected animal or animals.

SEC. 3. When any animal so examined is found by said commissioner or his assistant to exhibit the physical symptoms of glanders or farcy, it shall be destroyed and the carcass disposed of as said commissioner shall direct, at the expense of the owner thereof, without any compensation to said owner. An order for such destruction shall be issued in writing by the commissioner, and said order shall also contain such directions as to quarantine and disinfection of the premises where such animal or animals were stabled as may be required for the public safety; but no such quarantine shall exceed a period of ten days.

SEC. 4. The commissioner shall, with the approval of the governor, make such rules and regulations for the inspection and examination of animals and premises that have been exposed to infection by glanders or farcy as he may deem to be necessary to the purposes of this act. When said commissioner shall suspect any animal to be infected with glanders or farcy, he may issue to the owner or person in charge thereof an order to quarantine said animal, which order shall be in force until such time as the commissioner shall be satisfied that the disease exists or does not exist; but such quarantine, at the discretion of the commissioner, need not prohibit or restrict the free use of said animal, other than the disposal thereof. Inspection of said animal shall be made from time to time under the direction of the commissioner until said quarantine is terminated or said animal is destroyed. Any person who violates any provision of this section or

any order of said commissioner authorized hereby, or who interferes with or obstructs the commissioner or any assistant employed by him in the discharge of his duties as herein provided, shall be fined not more than one hundred dollars, or imprisoned not more than thirty days, or both.

SEC. 5. If the owner of any animal suspected of being infected with glanders or farcy and the commissioner are unable to agree as to the existence of such disease, the actual condition of the suspected animal shall be determined by arbitrators, one of whom shall be selected by the commissioner and one by the owner; and if said arbitrators cannot agree, they shall select a third arbitrator; if the said owner neglects or refuses for twenty-four hours to select the arbitrator to be chosen by him, the arbitrator already chosen shall select such second arbitrator. Such arbitrators shall first appraise the animal, and if they shall consider said animal to be infected with glanders or farcy they shall order it to be destroyed forthwith; and if upon post-mortem examination said animal is found to be free from said diseases, the expense of arbitration and the value of said animal, appraised as aforesaid, shall, when approved by the commissioner, be paid by the state upon the order of the comptroller; but in all cases wherein the post-mortem examination reveals that the animal was diseased with either glanders or farcy, the expenses of said arbitration and appraisal shall be paid by the owner of said animal.

SEC. 6. The commissioner is authorized and empowered to employ assistants to enforce the provisions of this act, and such assistants shall have the same powers as the commissioner while so employed.

SEC. 7. Sections 2812 and 2813 of the general statutes are hereby repealed. The provisions of section 4374 of the general statutes shall not apply to cases of glanders or farcy.

Approved, July 19, 1905.

[House Bill No. 629.]

CHAPTER 164.

An Act amending an Act concerning the Sale, Use, or Exposure of Glandered Horses.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Section 1345 of the general statutes is hereby amended to read as follows: Every person who shall sell or offer for sale, or cause to be sold or offered for sale, or who shall use or expose, or allow to be used or exposed, any horse or other animal which he knows or has reason to suspect is affected with the disease known as glanders or farcy, whether such knowledge has been obtained by personal examination or otherwise, shall be fined not more than fifty dollars, or imprisoned not more than thirty days, or both.

Approved, June 21, 1905.

ACKNOWLEDGMENT.

To all veterinarians, county, town and city health officers, officers and agents of The Connecticut Humane Society, the farmers and dairymen in all parts of the state, and to many others with whom the commissioner has had official relations, he owes a debt of gratitude for their hearty co-operation, kindness and un-failing courtesy, and this simple acknowledgment is but a feeble expression of his appreciation and thanks.

Respectfully submitted,

H. O. AVERILL, *Commissioner.*

State of Connecticut
PUBLIC DOCUMENT NO. 29

ANNUAL REPORT OF THE TRUSTEES
OF THE
CONNECTICUT
AGRICULTURAL COLLEGE

AT
STORRS, CONN.

For the period embraced within the first day of December, 1904,
and November 30, 1905

PRINTED BY ORDER OF THE LEGISLATURE

THE JOURNAL PUBLISHING COMPANY
ROCKVILLE, CONN.
1906

PUBLICATION
APPROVED BY
THE BOARD OF CONTROL

THE Connecticut Agricultural College

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Professor of Dairy Bacteriology

¹Served during the College year 1904-1905, including the 1905 Summer School.

²Served as Treasurer until succeeded by Mr. D. W. Patten, a member of the Board of Trustees.

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*Resigned March 31, 1905; and was succeeded by Mr. E. D. Proudman as Steward.

The Storrs Experiment Station

A DEPARTMENT OF THE
CONNECTICUT AGRICULTURAL COLLEGE*

Station Council

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C. A. CAPEN,	Appointed by Board of Trustees
L. A. CLINTON,	<i>Ex officio</i> as Director
A. G. GULLEY,	Appointed by Station Staff
C. L. BEACH,	Appointed by Station Staff

Station Staff

L. A. CLINTON, M.S.,	Director
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A. G. GULLEY, M.S.,	Horticulturist
C. L. BEACH, B.Agr., B.S.,	Dairy Husbandman
B. B. TURNER, Ph.D.,	Chemist
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E. A. WHITE, B.S.,	Consulting Botanist
CHAS. THOM, Ph.D.,	Cheese Expert, Mycologist
A. W. DOX, B.S., A.M.,	Cheese Expert, Chemist
T. W. ISSAJEFF,	Expert Cheese Maker

*A separate report of the Storrs Experiment Station is annually printed.



To His Excellency HENRY ROBERTS,

Governor of the State of Connecticut:

I have the honor to submit herewith the Report of the Board of Trustees of The Connecticut Agricultural College for the fiscal year ended September 30th, and for the year in other matters ended November 30, 1905.

Very respectfully,

C. A. CAPEN,

Secretary of the Board of Trustees.

REPORT OF THE PRESIDENT

To the Trustees of the Connecticut Agricultural College:

The annual reports of members of the College Faculty for the year 1904-1905 I have the honor of herewith spreading before you, together with the report of the Treasurer and the certificate of the Auditors of Public Accounts approving it. With the advice and consent of the Comptroller, the College Catalogue will be published later, under separate cover, in a larger edition for more general distribution.

The new Catalogue will contain all matters of interest to prospective students, but on request will be sent to all who desire detailed information regarding the present equipment of the College and the courses of study it will next year provide. Its announcements will be found of prime importance to the Connecticut farming community.

Ignorance of the precise nature of our institution and of the objects served by it, has led to public statements in previous years which have been at once untrue and misleading. Happily, however, more recently this ignorance has been largely dispelled. Repeatedly it has been observed that men formerly opposed to the College who at last have come to know what we are doing, are counted among our most intelligent and ardent advocates. It is now better known that we are not duplicating instruction elsewhere available in the State, but, on the contrary, are providing training not elsewhere to be had except at distant institutions which have established teaching similar to our own—such institutions as the Massachusetts Agricultural College, the College of Agriculture of Cornell University, and the University of Wisconsin Agricultural Department.

“Back to the farm!” is a gospel of hope to a host of dwellers in town, both rich and poor; and “Back to the New England farm!” is now the cry in the West, where markets are inferior to our own and where land is so dear that only the few can own it and work it with profit. Country establishments

fit to be the pride of any commonwealth are now multiplying in Connecticut, and many of our once abandoned farms are being reclaimed and are becoming wealth-producers under our modern methods of tillage. With some, health, wholesome living, and beauty are the objects sought. With others, the impelling motives are thrift, quest of an attractive vocation, pecuniary profit. Knowledge and skill in agriculture have never before been at such a premium. Magazines devoted to gardening, orcharding, live-stock, and outdoor adornment are multiplying. Of trained men and women there are vastly too few to meet present demands, let alone those of the immediate future. And nowhere, perhaps, is this trend more clearly and unmistakably registered than in the correspondence and activities of the agricultural college and experiment station.

The agricultural college to-day is the clearing-house for the best agricultural ideas and methods. If there have been fool professors, there also have been fool farmers; both have undoubtedly received their deserts. The outstanding facts to-day are mutual confidence and mutual assistance. There is an incessant pilgrimage from the field and stable to the laboratory and class-room, and from the college to the farm. Letters fly back and forth, netting something, now to knowledge, now to skill, now to the purse and the comforts—even the luxuries—of the rural and the suburban homes. Agricultural conferences, institutes, and conventions to-day make enormous demands on the agricultural teacher; but often he gets as much as he gives, and the best he gets he gives again, to fathers at home, and to the boys in his classes.

What is true of other agricultural colleges is equally true of our own. Our men are continually consulted about details of farm management, and constantly are giving advice about feeds, fertilizers, spraying formulas and apparatus, construction and ventilation of farm buildings, the production and marketing of wholesome and attractive farm products. Some of these inquiries come from novices at farming, some from men long in the business. A radical change is evident—from being regarded as an institution likely to require more or less copious expenditure of public funds, our institution has come to be looked upon as a valuable public asset, not so much as a source of public outgo, as a source of public income.

To be of public benefit in the largest sense, it is perhaps needless to say, is our highest and keenest ambition. Founded for increasing proficiency in the business of farming, and fostered by the grants of federal funds for promoting the "liberal and practical education of the industrial classes in the several pursuits and professions of life," if we have paid greatest attention to developing efficient agricultural instruction, it has been with knowledge that improved farming must be of immediate benefit not only to farmers, but also to all consumers of our farm products, and with knowledge that without our courses there would be in our State neither an agricultural school nor a college of agriculture where such instruction could be secured.

We have tried to be intelligent. While always giving the leading place to agriculture, we have offered modest courses of study in the various subjects permitted by the acts of Congress, from the proceeds of which the salaries of our teaching force are paid. This, however, we have done largely with a view to furnishing the public, as well as ourselves, with an actual demonstration as to what in Connecticut ought to be the work of the land-grant college. With a perfectly free choice amongst the courses offered, the demand during the past four years has been increasingly directed toward our courses in dairying, fruit-growing, and poultry culture. So far our women's building for instruction in domestic science has been adequate to the demands for instruction in this branch of our co-educational work. Our dormitories and the boarding places in our neighborhood for men, however, have not been adequate for receiving all applicants. And when the need of erecting a new dormitory came before the last General Assembly for consideration, it was the great farmers' organization—the Grange—that filled the largest assembly hall at the Capitol with people who had traveled from all quarters of the State to express their appreciation of the College and their desire that its work be furthered.

It is with the utmost confidence, therefore, in the usefulness of our institution as an agricultural college that I hand you these reports of my colleagues and direct attention to their work and needs. We feel that we are hand in hand with each

other and with the people we were created and are peculiarly fitted to serve. We are grateful—we cannot put into words how grateful—for the generous public endorsement of our work and aims which we have received in the noble brick and stone dormitory now in process of erection. This building we have named “Storrs Hall” in honor of the founder and first benefactor of our institution. Its sixty-six bed-rooms and thirty studies we hope will be ready for use at our fifth annual summer school for teachers and others in nature and country life subjects, which will be held next July; we hope to see every room taken by young men when our next fall term opens; and we expect to place extra beds in all of the studies next winter for short course students in dairy and creamery work, in pomology, and in poultry raising. We hail the new hall as a beautiful and enduring embodiment of the hope of the fathers and mothers. We crave no prouder distinction than to be permitted to lend a hand to more and more of their sons and daughters.

Very respectfully submitted,

RUFUS WHITTAKER STIMSON,

President.

REPORT OF L. A. CLINTON, M.S.,

Professor of Agronomy.

To Rufus Whittaker Stimson, President:

No radical changes have been made in the work of the Agricultural Division during the past year. The class room instruction has been along the same lines as mentioned to you in my last annual report.

In the Junior year all students in the agricultural courses take the work in Agricultural Physics. The Junior class taking this work is very largely made up of students who enter as graduates from high schools for the special two years' course. The work done by these students as a whole has been

very satisfactory indeed, and I hope to see a constantly increasing number of students enter for this two years' course preparatory to farming.

In the Senior year an opportunity is given to the students taking the agricultural work to specialize either along dairy lines or along lines of horticulture. During the winter term all of these students are given instruction for five hours a week in the general subject of Rural Economics. In this work we include bookkeeping as applied to farm practice. As a rule farmers are deficient in business training. Seldom do we find any books kept on the farm, and the reason for this is in part due to the fact that the ordinary commercial bookkeeping is too complicated for the farmer's use. We endeavor to teach a system of farm accounts which is practical and which is not so complicated as to preclude its use on the farm.

During the spring term of the Senior year those students selecting work along the lines of general agriculture and dairying are given instruction for five hours a week on the methods of raising farm crops. For some reasons I would prefer giving this instruction during the Junior year. The larger number of our students who graduate, even though they may specialize along the line of Horticulture, will, without doubt, find it necessary to raise the general farm crops. Under the present system these students receive no instruction in this line of work. Only the very full schedule during the Junior year prevents me from recommending the transference of the course in farm crops from the Senior to the Junior year.

The winter course is deserving of special attention, and we believe that there is no department of our work which will give us more direct influence with the agricultural classes of the state. As soon as our dormitory facilities are sufficient to enable us to accommodate more students here, we hope to see the winter course made an important feature of our work.

While at present we are not conducting any work which is called "college extension work," yet there is a very frequent call for lectures at farmers' institutes throughout the state. I understand that it is your desire as well as the desire of the Board of Trustees that so far as we are able without seriously interfering with our class work we attend the farmers' meetings throughout the state. These demands are especially heavy

during the winter, but they serve to keep us in close touch with the people whom we can best serve.

Some improvements have been made on the College farm, but these have not been as extensive as we could have hoped for. We hope, however, to make some slight improvements each year, so that the general condition of the farm will be improving rather than deteriorating.

I wish to acknowledge my appreciation of the services of the Farm Superintendent, Mr. H. L. Garrigus. He has given faithful attention to the details of the farm management.

Respectfully submitted,

L. A. CLINTON.

REPORT OF A. G. GULLEY, M.S.,

Professor of Horticulture.

To Rufus Whittaker Stimson, President:

The Horticultural Department has very little to report that has not already been referred to in previous years, as methods in both class-room and field have not recently changed.

Except in one direction no material addition has been made to the equipment, and until this is done no important change can be made to add to the effective work of the department. Room and other facilities must soon be added to hold horticultural teaching even at its present standard, to say nothing about broadening its field.

The exception noted above is in spraying machinery. Addition was made to that the past season. The College probably now owns the most complete outfit in the State, and embracing some of the most recent improvements to effectively carry on that comparatively new branch of horticultural operations.

Some of the results of earlier work in the department are now evident in the production of fruit. A large part of the earlier planting in the trial orchard is now bearing, and a large crop was produced the past season in the commercial planting of peach and plum. This last, from now on, will be a regular source of more or less income.

A pressing need of horticulture at the College is a permanent and proper location for small fruit and vegetable growing. These crops in the past have been shifted to suit convenience, but much to the detriment of economical operations. Land for vegetables has been partially provided for in the swamp land drained and fitted some years since by the department, but in addition an elevated field which can be permanently fitted for some of the crops is very necessary.

Respectfully submitted,

A. G. GULLEY.

REPORT OF C. L. BEACH, B.AGR., B.S.,

Professor of Dairying.

To Rufus W'hittaker Stimson, President:

I present, herewith, the report of the Dairy Department for the year ending October 31, 1905.

My work during the past year has included instruction in the nutrition of farm animals, history of dairy breeds, animal breeding and dairying. Stock judging and work in the dairy barn and creamery have supplemented the class-room work. As the schedule is now arranged, this instruction is given to the regular students in the fourth year.

During the winter term the same subjects are presented in separate classes to short-course students. This department is constantly in receipt of letters and inquiries for young men who have had some experience and training along dairy lines. In order to give these students as much attention as possible, I have asked the Committee on Courses of Study to transfer my classes in the winter term with the Seniors, to either the fall or the spring term. While this arrangement will necessitate a duplication of subjects presented and of class-room work, it should bring about better results.

The Dairy Department includes the dairy herd and the Creamery. Both these divisions are managed primarily for

purposes of instruction and experiment. The receipts from the Creamery will offset the disbursements, including the product from the College herd. The Creamery is conveniently arranged and well equipped for the purpose for which it was designed.

The dairy herd is managed under adverse conditions. It is isolated, cut off from the base of supply and the market for by-products. Roughage for the herd is purchased from the farm, and the profit from the crop accrues to the farm, and not to the herd. No charge is made to the farm for manure, and little revenue is derived from skim milk. These conditions should be borne in mind in reviewing the financial statement of this department.

Representative animals of the four dairy breeds — Ayrshire, Holstein, Jersey and Guernsey — are kept in the herd. This necessitates the feeding and handling of four mature bulls and a frequent change of sires to prevent inbreeding.

In the class-room especial emphasis is placed upon the importance of warmth, sunlight, ventilation and sanitation in developing and maintaining the artificial functions of dairy animals. The opposite of these conditions prevails in our dairy barn, and it must be obvious to every student that theory and practice are in conflict. It is my duty, therefore, to bring this phase of the matter to your attention and to urge its importance. A model dairy barn in which pure milk can be produced is as essential as a model creamery for the manufacture of the product.

Respectfully submitted,

CHARLES L. BEACH.

REPORT OF CHARLES K. GRAHAM,

Instructor in Poultry Industry.

To Rufus Whittaker Stimson, President:

The usual course of lectures was given to the regular students during the winter term. This consists of the distinguishing characteristics of the different fowls, selection of stock for breeding purposes, theory of feeding for both flesh

and egg production, artificial incubation and rearing of chicks, together with the different methods of killing and preparing fowls for market.

During the spring term practical training was given in the same subjects.

This year we have received seventeen new incubators, and these, together with a fair assortment of brooders, leave us well equipped in this line. The incubator cellar is easily ventilated and is in many ways ideal. The new brooder house has not been so satisfactory, especially during the winter months, when it has been found difficult to secure a proper amount of fresh air under the hovers. Some alterations have been made which I hope will overcome this trouble another winter.

We have five new colony houses built by the Experiment Station on plans different from the old houses. The latter are inexpensive buildings but of a very satisfactory type. We have a few old, long houses which are badly in need of repair. These I expect to tear down and rebuild with the assistance of the students on plans similar to those which are giving satisfaction. This will not only improve the appearance of the plant, but will make it much more compact and will give accommodations for about 600 laying birds. I hope we may be able to increase this number to 1,000, in order that stock enough may be grown to supply the Boarding Department and College community. We are now furnishing poultry and eggs to the College cheaper and better than they could secure these supplies elsewhere, and at the same time are making a profit.

Since January 1, 1905, I have spoken at nineteen farmers' meetings, and received and answered 2,732 letters. The number of letters seems to be steadily on the increase. Over 80 per cent. of these letters are from people in this State, and over 50 per cent. are from people asking advice. It has been thought advisable in many cases to visit these people, and I am pleased to report that many have expressed their appreciation of the trouble taken and in most cases have paid my expenses.

Respectfully submitted,

C. K. GRAHAM.

REPORT OF E. H. LEHNERT, B.S., D.V.S.,

Professor of Veterinary Science, Physiology, and Animal Husbandry.

To Rufus Whittaker Stimson, President:

I present herewith the report of the Department of Veterinary Science, Physiology and Animal Husbandry for the year ending October 31st, 1905.

Veterinary Science.—The time allotted to the study of this subject two years ago was found to be too short, and application for an additional hour each week during the winter term was granted, so that we have since been in position to accomplish the amount of work desired. Last year, as an innovation, with the conviction that more satisfactory work could be done, we adopted a text-book which was supplemented with lectures, detailed descriptions, etc. Our experience thus far bears out our conviction, and we have every reason to believe that the use of a text-book will prove very satisfactory to both teacher and student. This subject is taught the fourth year to those students electing Agriculture; five hours a week during the fall term and four hours a week during the winter and two during the spring are devoted to the work. The course has been shortened to such an extent that the work of necessity is of an elementary nature. The time during the fall term is taken up with a course in Veterinary Anatomy and Physiology, an outline of General Pathology and Materia Medica, with dissections afternoons and evenings after the Thanksgiving recess. Diseases and their treatment receive attention during the winter term. Constant use is made of models and specimens, of which we have a good equipment, also there are frequent operations on living animals. It is intended so far as possible with the limited time at our disposal, to give the student a thorough practical knowledge of the common diseases and accidents of farm animals, with the principles of nursing and the administration of the proper medicines. The students are not only given every opportunity for witnessing ordinary operations, but also assist when possible.

During the early spring of 1903 a perfectly appointed pharmacy was established in the horse-barn. This room is provided with a cement floor and is sufficiently large for operations on dogs and cats and such operations on the horse as do not

require casting. It is a great convenience in the cold weather, as it is heated. It is contemplated to install an operating table of our own design and manufacture in the near future. When this is done, we shall be in position to open the free clinic mentioned in my last report. The advantage to the student of a clinic of this nature would be difficult to estimate.

For the students in the B. S. course who elect this subject, we are allowed five hours a week for the full year. This enables us to go more deeply into the different branches of the subject and add lectures on stable construction, including ventilation, drainage, etc., with work in pathogenic bacteriology during the spring term.

Physiology.— This subject is taught during the spring term of the third year to all students. A standard text-book is used and is supplemented by lectures and practical work in the laboratory, illustrating the principles and processes of physiology, *i. e.*, digestion, contractile power of muscles, etc. A short time is devoted to the study of normal body tissues under the microscope (Histology), and dissections of the smaller animals.

The time given to this subject is four hours in the classroom and one afternoon in the laboratory each week. For class-room work we have at hand a fair equipment of models, including those of the ear and eye, and also an articulated human skeleton and a dissecting manikin.

Animal Husbandry.— (*Breeds.*) — To the study of breeds we devote three hours a week in the class-room, and two afternoons a week are utilized for practical work. This subject is taught the fourth year men of the Agricultural courses during the fall term. Our work is accomplished by the use of a text-book in the class-room, supplemented by actual study of representative animals of the different breeds, comparing the specimen at hand with the ideal type. All species of farm animals receive attention,—horses, cattle, sheep, and swine. It is our endeavor to bring before the class the best specimens possible, hence it happens occasionally that it is necessary to visit farms in other parts of the State. For practical work the student is required to score different animals from the standpoint of the judge. This exercise makes him familiar with the various breeds of horses, cattle, etc., and gives him a knowledge of the conditions to which each is best suited.

Horse-Barn.— Practical instruction in the care of horses, harness and carriages, hitching, unhitching and driving, as well as the general principles of nursing, bandaging, etc., is given the third year Agricultural students one afternoon a week during the winter term.

Elective Zoology has been this year added to my department; and it is my intention another year, if the subject is still in my hands, to make it as exhaustive as possible with the equipment at hand. This course consists of two recitations and one laboratory period a week for the entire year.

Respectfully submitted,

E. H. LEHNERT.

REPORT OF E. A. WHITE, B.S.,

Professor of Botany, Forestry, and Landscape Architecture.

To Rufus Whittaker Stimson, President:

I take pleasure in presenting the following report of the Departments of Botany, Forestry and Landscape Architecture for the year ending October 31st, 1905.

Botany.—The class-room work as outlined in the Course of Study has progressed satisfactorily. In addition to the regular class work scheduled for the year, there was a request from eight students of the fourth year class for lectures covering the classification and life history of parasitic plants of economic importance. This course was given with good results. At the beginning of the fall term, one student elected fourth year work, one third year, and one elected the fifth and sixth year work.

The lectures given before the summer school were well attended. I wish to express my appreciation of the kindness of the Board of Trustees in granting me a four weeks' leave of absence in consideration of my work in the summer school. I plan to spend the month of January, 1906, at Harvard University, doing some special research work in the botanical

laboratories of Dr. W. G. Farlow, and in attending lectures in Botany by Professor M. L. Fernald and Dr. Jeffery, also those by Mr. Frederick Law Olmsted, Jr., in Landscape Architecture. These gentlemen have very kindly extended to me the privileges of their departments.

During the year my first report on the fleshy and woody fungi of Connecticut has been published by the State Geological and Natural History Survey. A further report is now in preparation.

Landscape Architecture.—This year, for the first time, there has been a request for lectures upon Landscape Architecture. These are given to one member of the fourth year class, two members of the fifth year class, and one special student. It is planned to make the course a practical one. In October the class visited Hartford, upon the invitation of Mr. G. A. Parker, Superintendent of Keney Park, and was driven through the extensive park system. The department feels deeply indebted to Superintendent Wirth of the Hartford park system and to Mr. Parker, for their many courtesies on this occasion. Several trips to private estates have been planned for the coming spring.

The practical work in landscape gardening upon the campus has progressed slowly because of the lack of funds necessary to carry on the work. One or two small areas were graded during the year, a hedge of evergreens planted for a wind-break at the Poultry Department, another group was planted near the horse-barn, and a large number of shrubs were set about the main building. The drive around the western side of the pond was finished, and several of the drives have been topped with gravel. It would be highly desirable if enough crushed stone could be obtained to retop the main drive through the grounds. It is four years since the drive was constructed, and it is becoming badly worn.

Forestry.—The work in Forestry with the fourth year class was conducted as in previous years.

Respectfully submitted,

E. A. WHITE.

REPORT OF C. A. WHEELER, M.A.,

Professor of Mathematics.

To Rufus Whittaker Stimson, President:

There have been few changes in my subjects during the year covered by this report. The work in Freehand Drawing, concerning which I wrote somewhat fully in my last report, was carried through the year as planned, and the objects drawn and dates were as follows:

- 1 Three types of bean-pods: long, broad, short
November 2d
- 2 Three types of squashes: long, round, flat
November 9th
- 3 Three types of onions: long, round, flat
November 16th
- 4 Coleus slips in pots
November 30th
- 5 Three types of potatoes: long, 'round, intermediate
December 7th
- 6 Ear of corn (flint)
December 14th
- 7 Flask (outline)
January 4th
- 8 Flask (shaded) with dark background
January 11th
- 9 Retort and holder
January 18th
- 10 Same, in ink and shaded
January 25th
- 11 Glass bulbs, spirals and other chemical apparatus
(outline)
February 1st
- 12 Watering pot and basket (contrast, smooth and
rough outlines)
February 15th
- 13 and 14 Same, reduced, with pencil, then in ink
March 1st and 8th
- 15 Pots and baskets in group and memory sketch
March 15th

The subjects of the fall term are horticultural and agricultural; of the winter term, chemical and artistic; and of the spring term, botanical. The best drawings of the fall term were made by Gould (4), M. H. Griswold (3), Burgess (3), Farrand (2) and Lawrence; of the winter term, by M. H. Griswold (5), Burgess (2), Farrand, Garden, and Woodruff; and of the spring term, by Dyson (3), Burgess (2), Lawrence, and Stubbs. The change is now completed from the method

formerly employed of working from plates and casts, and the results have been better than was expected; for not only have my students made great improvement in drawing, but they have at the same time been studying objects with which they are directly concerned and about which they are able to pass good judgment. The best drawings as they have been exhibited each week have excited the studious comment of the competitors, and of the upper class men, also; and an exhibition of the year's work, recently, brought forth from members of the faculty expressions of interest and appreciation.

The average number of students per class is now ten, a slight decrease from last year, the largest class numbering eighteen and the smallest four; and it is interesting to note that the average is about that of colleges throughout our land.

During the spring term I was assisted in instructing the third year class in surveying by Mr. Shurtleff and Mr. Nash. In this way the class was divided into three squads of six students each and the squads instructed in rotation, thus increasing the efficiency of the instruction and utilizing all of our surveying instruments.

A larger part of my time than previously has been used in surveying. Three topographic surveys were made and three maps plotted of the site for Storrs Hall, some new measurements were taken and many old ones used in preparing a map showing the location of buildings with respect to fire risks, and a line of levels was run and a profile plotted for an extension of our sewage system.

It was my good fortune during the long vacation to have further experience in matters which I teach, viz., the building of a good road, the preparation and use of concrete, both with and without reinforcement, and the survey for a trolley road.

Though the past year has been from every point of view a successful one, we look forward with pleasure to larger classes and a larger usefulness, made possible by the building of a substantial and generous dormitory.

Very respectfully submitted,

CHARLES A. WHEELER.

REPORT OF H. R. MONTEITH, B. A.,

Professor of History, Civics, Latin, and Mathematics.

To Rufus Whittaker Stimson, President:

The classes under my care have followed closely the courses as outlined in the schedule of studies for this department. The results have been fairly satisfactory. United States history has commanded an excellent degree of interest, and in consequence substantial progress has been made. The same is true of the other classes in history. There has been no call this year for the electives in history.

Civics, associated with the Freshman history, has, from the beginning, proved both interesting and profitable. I regard the results of this course particularly valuable.

Latin, although our course is elementary, seems to have made a place for itself in our curriculum. While there is, and I believe should be, no attempt at anything more than the elementary course now in use, the diligence of the students in this study and the success so far attained certainly justify its retention. It is noted, too, that this course has stimulated interest in other branches.

In mathematics the arithmetic and algebra have fallen to me. Time will probably prevent the extension of the former.

In my department commendable progress has been made, and If, without intrenching upon the work of other departments, a somewhat longer period could be assigned to the algebra, the result would probably justify the added effort. The students as a whole greatly enjoy this branch of mathematics and usually regret that our work is confined to the elements.

In my department commendable progress has been made and the year just closed has, in consequence, been more than usually successful.

Respectfully submitted,

H. R. MONTEITH.

REPORT OF EDWIN OSCAR SMITH, B. S.,

Professor of English and Political Economy, Secretary of the
Faculty, and Treasurer of the Board of Trustees.

To Rufus Whittaker Stimson, President:

There have been, during the past year, no changes in the schedule for the various courses that have affected my work.

The courses in English in the first two years include spelling, grammar, rhetoric, and composition. To give time in the first year to spelling and grammar seems unavoidable, in view of the deficient preparation of the average student admitted. The beginning of English composition is therefore deferred to the second year, in connection with the study of rhetoric; this course being supplemented by the present effective work in composition in the third year, required of all regular students.

In the required course of political economy the economic history of the country is sketched, and an attempt is made not only to acquaint the student with the chief points of theory, but particularly to awaken on his part a lively interest in our economic problems.

The expected increase of students during the next year makes more pressing the need of a gymnasium. This feature of school and college equipment is so generally regarded as indispensable that the present lack of gymnasium facilities here is a source of dissatisfaction to students and a handicap to the institution that should be removed at an early date.

Respectfully submitted,

EDWIN O. SMITH.

REPORT OF FREDERIC W. PUTNAM, B.S.,

Professor of Mechanic Arts.

To Rufus Whittaker Stimson, President:

The present College year opened with about the same number of students in my classes as last year. One student is taking regular fourth-year work in Mechanic Arts, and one student is taking, this year, a special course of twenty-two hours a week in Advanced Mechanical Drawing, Machine Design, Pattern Making and Molding, for the purpose of fitting himself for practical work in the drafting and designing room of a large machine company.

In my last report I recommended that the third-year Agricultural students be given six hours a week in Mechanical Drawing during the fall term, instead of three hours as scheduled. When the schedule was made up this year by the Course of Study Committee it was found, however, that it would be impossible to arrange for the extra three hours, so I have, in order to save time in the dictation of notes, in both drawing and shop work, supplied the students with sets of printed notes, thus enabling the men to devote all their time in the class-room to practical work.

It was found that the students last year accomplished considerable more work than was required in last year's schedule of Mechanic Arts. This year the various courses have been strengthened considerably by the addition of several more practical problems in Drawing and Exercises in Shopwork.

The moving and fitting up of the Blacksmith Shop with power machinery will enable us to properly give students instruction in Wood Turning, Pattern Making and Molding. This building will also give us room enough for the installation of two or three metal working machines, and I hope that next year the College may be able to make a start in this direction.

Respectfully submitted,

FREDERIC W. PUTNAM.

REPORT OF THE REV. H. E. STARR, A.M.,

Professor of English and Ethics, and College Chaplain.

To Rufus Whittaker Stimson, President:

I have the honor of presenting to you my annual report for the year 1904-5.

It has been my duty to conduct the Chapel exercises and to give instruction to students of the Senior Class in English composition, English literature and ethics. While I have required from the students as much written work as I felt that I reasonably could, and carefully criticised it before them, I have devoted a larger portion of the time to work in English literature. My aim has been three-fold: first, to give the students a general knowledge of the development of English literature which will serve as a guide for future reading, or as a foundation for more advanced study; second, by requiring them to do a considerable amount of reading to acquaint them with the principal authors of the nineteenth century; and third, to develop within them a taste for the best literature.

Two hours a week during one term have been devoted to ethics. The time was given to the discussion of the general principles which underlie conduct.

I have found the students responsive and willing to work. The results, I believe, have been as satisfactory as could be hoped for.

Respectfully submitted,

HARRIS E. STARR.

REPORT OF B. B. TURNER, Ph.D.,

Professor of Chemistry and Physics.

To Rufus Whittaker Stimson, President:

Mr. H. R. Wade, B.S., who acted as assistant in this department during the first part of the year, resigned in November, 1904, to take a position in Lowell High School, and his place

was filled by Mr. Herman D. Edmond, B.S., a graduate of this institution.

In January, 1905, the class previously suggested in Elementary Science was commenced, and has been continued each term since. This has been useful to many students in laying some slight foundation for the scientific studies of the year now opening (October, 1905); for others it has acted as a useful discipline and foretaste of the serious requirements of the Sophomore work in science. I feel sure it is a step in the right direction.

Many students still find chemistry and physics difficult subjects. In the former, however, there is decided improvement, and I have been able to gradually raise the standard; and although a large number have still to be conditioned in physics, I feel sure that better work will be done as the need of serious application is felt. With the exception of such students as were incapable all round, almost all of those conditioned in the past have worked off their conditions, with decided benefit to their education. The standard is still none too high, because a general lack of training in habits of attention and study and much incapacity in such necessary preliminary subjects as arithmetic, algebra, English, etc., makes progress unavoidably slow. Too many of our students have the habit of thinking a subject done with as soon as the term examination is passed, with the result that when it is needed as a basis for more advanced work, the foundation has to be laid again. My aim in my own subjects has been to limit the ground covered and try to teach the elements so that they can be actually utilized by the student in later studies. It is largely to that that I attribute the sense of difficulty which chemistry and physics have inspired among our students.

Respectfully submitted,

B. B. TURNER.

REPORT OF ALBERTA TULLIA THOMAS,

Professor of Domestic Science and Art, and Lady Principal.

To Rufus Whittaker Stimson, President:

I. Care of Grove Cottage. The routine of the life in Grove Cottage and its management continues the same from year to year. The students care for their own rooms, and take much pride in the arrangement and care of them. The standard of order and cleanliness is high.

II. The Chaperonage of the Young Women. We endeavor to surround our young women with as home-like an atmosphere as is possible. Our aim is to send out from our school self-controlled, self-respecting young women. The ordering of our daily life here is arranged with this thought uppermost. At our social functions the young women assume the various responsibilities of a hostess.

The general health of the young women is good and we have comparatively little sickness.

III. Household Economics. The aim and scope of this department is described in detail in the catalogue under schedules 10, 11 and 12.

Last year completed the four years' course which was laid out when I took charge of the department. Two young women received the diploma of the College last June. Both graduated from this department. These two students have returned this year to continue their studies in Household Economics with a view to making professional use of it. That the young women take an interest in this line of work is shown by the number who elect Course No. 11. At the beginning of the third year a large percentage of the special students elect courses in this department also.

Respectfully submitted,

ALBERTA T. THOMAS.

REPORT OF ANNA W. BROWN,

Professor of English, Elocution, and Gymnastics.

To Rufus Whittaker Stimson, President:

The courses in Elocution remain essentially the same as when organized at the beginning of my teaching at the College two years ago. For a detailed account of these courses I will refer you to my report of 1905. All regular students, except Agricultural and Horticultural Seniors, are required to take class-room instruction in Elocution throughout the year. In a culture subject, where results depend on the constant and systematic study of problems and the practice of exercises, such results can be secured only after months of effort. I feel sure that the good work in Elocution noted in the Rhetoricals of the fall term of this year is due, in part at least, to this continued, systematic instruction and to the steady discipline of the classes in the essentials of reading and speaking. The students are also showing an increasing interest in their work and a growing respect for it. This has been noted in the class-room and in the improved deportment of the students at the Rhetoricals.

The class in Junior English reports to me for three hours each week. Up to the present time the emphasis has been largely placed on narration and description in theme writing, the work beginning with short daily themes which were later displaced by tri-weekly compositions. During this time Addison's "De Coverley Papers" were read, discussed, and used as a partial basis for theme work. The class is now reading Southey's "Life of Nelson," and writing weekly themes in exposition. Other prose masterpieces will be studied later, and during the spring term attention will be given to the form and content of selected English poems.

Respectfully submitted,

ANNA WEST BROWN.

REPORT OF W. A. STOCKING, JR., M. S. A.,

Professor of Dairy Bacteriology.

To Rufus Whittaker Stimson, President:

The work of instruction in this department during the past year has been similar to that outlined in my last report. The third year students in Agriculture, Horticulture and Domestic Science are given a general course in laboratory work supplemented by occasional lectures. This course is intended to make the students familiar with the methods of handling and studying bacteria. Considerable time is given to microscopic work.

Because of the over-crowded condition of the laboratory it has been impossible to give some of the important parts of this course. During the latter part of the term some of the problems relating to the farm and household in which bacteria play an important part are studied. This course forms a foundation for the other courses in bacteriology.

During the spring term the fourth year students are given a course in dairy bacteriology. This is intended to make the students familiar with dairy problems and conditions which result from the presence and growth of bacteria. Their occurrence and action upon milk are studied together with methods for excluding and checking bacterial growth. The method of making home starters, the production of sanitary milk, and other practical problems of special interest to the students are taken up in this work.

During the winter term a course of lectures and laboratory work is given to the short course dairy students. This course is designed to fit students for making bacterial determinations of milk and other dairy products and to control the development and action of bacteria in the handling of milk and cream. They are given the methods for making all the necessary culture media, for sterilizing materials, and all the technique necessary for making plate cultures and isolating individual species of bacteria for use in making home starters.

Besides those mentioned above, courses in advanced work are given to students who are candidates for the B. S. degree.

These courses are designed to give men a good general training in bacteriological technique and experience in various lines of investigation in dairy and soil bacteriology.

The room in Agricultural Hall which is used for this work is too small for the needs of the regular courses. The equipment is also insufficient for the needs of the work. It would be very desirable if a larger room could be provided, but the present one could be much improved if a better equipment could be provided.

Meteorology.—A course of two hours per week in meteorology and climatology is given during the fall term to the third year students in Agriculture and Horticulture. This course includes a study of the principles upon which the weather conditions and changes are dependent and their effect upon the various problems of the farmer. It includes a study of dew and frost formation, the relation of rainfall to crop production and other problems in connection with farm operations. A more detailed outline of this course may be found under "Courses of Study" in the catalogue.

Respectfully submitted,

W. A. STOCKING, JR.

REPORT OF EDWINA MAUD WHITNEY, Ph.B.,

Instructor in German, and Librarian.

To Rufus Whittaker Stimson, President:

Library.—The report from the Library Department remains essentially the same as that of last year. We have accessioned from November 1, 1904, to November 1, 1905, 223 volumes, making a total of 10,368. Of these 114 have been bought, and 109 were donated, mainly from the government at Washington and the Connecticut State Library. We have also, through the kindness of Congressman E. S. Henry, been able to add a good many volumes of the rarer government reports to our already valuable list. In this connection I would like to make mention of the interest which Mr. C. R. Green of the Connecticut

State Library has shown in aiding us to complete our file of College Lookouts. Before another year we hope to have the collection completed and the volumes bound. This, when done, will prove a valuable addition to our somewhat scanty supply of data concerning the history of our college.

German.—The interest in German has increased slowly but steadily since the introduction of the course. I am glad, therefore, to report that the total number of students selecting German at the beginning of this college year is larger than ever before. The general scope and trend of the work does not permit of many changes. Little attention is paid to the classics, but the aim is to teach the student to read with comparative ease modern German both colloquial and scientific. Since the expansion of the course to five hours a week, there has been no difficulty in creditably performing this work.

Respectfully submitted,

EDWINA WHITNEY.

REPORT OF E. D. PROUDMAN,

Instructor in Stenography, Typewriting, and Penmanship.

To Rufus Whittaker Stimson, President:

It is with pleasure that I hand you my third annual report.

The work given the freshman class in penmanship is just the same as in previous years, and they are doing good work.

One student finished the stenography and typewriting course last June, and on his final examination took dictation at the rate of 108 words per minute. There was one student in the advanced class this fall, but he left soon after the opening of the term, owing to the fact that his folks moved out of the State. Two new students entered the course and are making very good progress.

Respectfully submitted,

E. D. PROUDMAN.

REPORT OF E. R. BENNETT, B.S.,

Instructor in Military Science.

To Rufus Whittaker Stimson, President:

The work in the Military Department has been practically the same as that of last year. Three hours a week have been devoted to field work in Military Science. The instruction has covered close and extended order, work in squad, platoon and company drill, manual of arms and "setting up" work.

Dormitories are inspected each day except Saturday by the Department.

All cadets are required to wear the regulation, blue, army uniform.

Class room instruction in drill regulations has been given the second year students one hour per week during the winter term.

Lack of indoor space in which to drill during the stormy weather is a serious handicap to the Department.

My work as instructor in Geology, Entomology and Ornithology began with the fall term of this year. Three hours a week of this term are being devoted by the fourth year students to the study of Geology. Dana's Revised Text Book of Geology is used as a text book. The aim of the Department is to give students a general idea of our rocks and minerals and the relation of Geology to Agriculture. Work in Ornithology will be given the third year students during the winter term, and Entomology to the same students during the spring term.

Respectfully submitted,

E. R. BENNETT.

REPORT OF EMMA H. KOLLER,

Instructor in Music and Assistant to the Lady Principal.

To Rufus Whittaker Stimson, President:

The progress of the freshmen in singing last year was very satisfactory. In April the class had completed the work the previous class had taken a year to accomplish.

The private pupils in piano and voice gave two recitals, one at the end of each of the first two terms. The programmes were well rendered and showed careful and conscientious work. I gave a vocal and a piano recital. Music was furnished at rhetorical and entertainments.

The second term I had a general class, which is not in the schedule. Hand culture, ear training and elementary harmony were studied. At the end of the term an examination was given and the standings recorded.

The glee club was given up with regret, as I had no evening off from chaperoning at the Cottage that corresponded with the free time of the boys. This year Professor Putnam has kindly consented to take up the work.

Respectfully submitted,

EMMA H. KOLLER.

INVENTORIES

Sept. 30, 1905

FARM

Live stock	\$1,858.00	
Farm products	2,130.00	
Machinery, implements, tools	2,094.55	
		\$6,082.55

DAIRY AND CREAMERY

Live stock	\$4,655.00	
Equipment and supplies	5,213.17	
		\$9,868.17

POULTRY

Old stock	\$198.00	
Young stock	521.84	
Office furniture	51.00	
Supplies	84.15	
Equipment	357.65	
		\$1,212.64

HORTICULTURE

Tools and equipment	\$575.55	
Fruits, vegetables, nursery stock	152.50	
Greenhouse stock	459.80	
		\$987.85

BOTANY, FORESTRY, AND LANDSCAPE

ARCHITECTURE

Botany equipment	\$347.10	
Forestry equipment	91.50	
Landscape architecture equipment	253.25	
		\$691.85

BOARDING

Equipment and supplies	\$2,003.67
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HORSE BARN.

Wagons and sleighs	\$393.00
Harness, blankets, robes	300.75
Feed, tools, miscellaneous equipment	315.15
Horses	2,900.00
	\$3,908.90

MECHANICS

Carpenter shop equipment	\$618.01
Paints, etc.	41.96
Plumbing supplies	106.85
Blacksmith shop equipment	273.70
	\$1,040.52

NATURAL HISTORY

Apparatus	\$1,050.00
Museum	5,000.00
	\$6,050.00

MATHEMATICS

Instruments, models, etc.	\$1,028.69
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VETERINARY SCIENCE, PHYSIOLOGY, AND
BACTERIOLOGY

Instruments, models, apparatus, etc.	2,870.81
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CHEMISTRY AND PHYSICS

Physical apparatus	\$1,303.00
Chemicals	242.65
Chemical Apparatus	1,460.00
	\$3,005.65
Military equipment	436.13
Grove Cottage equipment	2,747.50
Library books, shelving, furniture	20,551.00

GENERAL EQUIPMENT

Telephone system	\$350.00
Wagon scales	150.00
Fire extinguishers	400.00
Dormitory furniture	1,657.10
Janitor's supplies	143.05
Miscellaneous equipment, office furniture and supplies	6,905.34
	9,695.49
Lands and buildings	\$129,000.00
	\$201,181.42

TREASURER'S REPORT

REPORT OF E. O. SMITH, TREASURER OF THE CONNECTICUT AGRICULTURAL COLLEGE, FROM OCT. 1, 1904, TO OCT. 1, 1905.

	RECEIPTS.			DISBURSEMENTS.		
	CASH	TRANSFER	TOTAL	CASH	TRANSFER	TOTAL
Annual State Appropriation (State Fund),...	\$20000.00	.....	\$20,000.00	.....	.....	.....
Endowment Income (Land Grant Fund),...	5725.56	.....	5725.56	.....	.....	.....
Annual Federal Appropriation (Morrill Fund),...	25000.00	.....	25000.00	.....	.....	.....
Hicks Prize Fund,	60.00	.....	60.00	\$68.00	.....	\$68.00
Interest,	443.58	.....	443.58	.....	.....	.....
Miscellaneous receipts,	119.57	.....	119.57	.....	.....	.....
Salaries:						
Officers, .....	.....	.....	.....	*6578.85	.....	6578.85
Instructors, .....	.....	.....	.....	24055.22	.....	24055.22
Lecturers, .....	.....	.....	.....	680.05	.....	680.05
Departments:						
Library,—						
New books, .....	.....	.....	.....	.....	.....	.....
Periodicals, .....	.....	.....	.....	102.53	.....	102.53
Librarian's student assistant, .....	.....	.....	.....	190.68	.....	190.68
Farm,	1063.70	14217.90	6581.00	96.77	.....	96.77
				4718.41	168.68	4887.09

*The salaries here included are those of the secretary and the auditors of the Board of Trustees, and of the president, the librarian, the chief clerk, the stenographer, the bookkeeper, and the boarding department manager of the College.

†"Transfer" amounts represent transactions among the different College departments, and cover such items as labor and materials furnished one department by another.

ANNUAL REPORT OF THE

TREASURER'S REPORT (Continued)

	RECEIPTS.			DISBURSEMENTS.		
	CASH	TRANSFER	TOTAL	CASH	TRANSFER	TOTAL
Dairy and Creamery,	\$4712.45	\$4179.71	\$8892.16	\$9049.54	\$938.47	\$9988.01
Poultry,	778.85	565.27	1344.12	1274.41	121.47	1395.88
Horticulture,	1198.14	201.61	1399.75	2215.15	267.86	2483.01
Forestry, Landscape and Botany, including care and permanent improvement of grounds,	13.75	91.55	105.30			
Horse Barn,	797.23	4026.43	4823.66	875.52	284.24	1159.76
Boarding,	12998.18	1700.08	14698.21	3257.01	1551.56	4808.57
Military,				11912.09	6208.29	17120.38
Buildings:				113.07	.....	113.07
Breakage,	224.20	.....	224.20	195.42	28.87	224.29
Repairs, additions, and improvements not elsewhere included,				3242.61	173.48	3416.09
Architect's fees (Storrs Hall),				1500.00	.....	1500.00
Rent,	900.83	.....	900.83	272.66	.....	272.66
Fuel and light (material),	2055.39	.....	2055.39	3448.88	1374.00	4817.88
Equipment:						
Repairs, additions and improvements not elsewhere included,				509.89	13.39	523.28
Facilities for instruction:						
Apparatus,				220.31	.....	220.31
Supplies,				485.12	39.00	524.12
Insurance,				1126.00	.....	1126.00
Students' stationery and supplies,	2466.72	.....	2466.72	2466.56	.....	2466.56

TREASURER'S REPORT (Continued)

	RECEIPTS.			DISBURSEMENTS.		
	CASH	TRANSFER	TOTAL	CASH	TRANSFER	TOTAL
Students' laundry,	\$1426.59	.....	\$1426.59	\$1345.55	.....	\$1345.55
Medicines,	31.00	.....	31.00	54.75	.....	54.75
Pew rent for students, .....	.....	.....	.....	400.00	.....	400.00
Administration, general:						
Freight and express, .....	.....	.....	.....	173.68	.....	173.68
Cartage and transportation, .....	.....	.....	.....	43.00	\$3687.72	3690.72
Entertainment of guests, .....	.....	.....	.....	20.76	260.76	281.52
Commencement, .....	.....	.....	.....	133.67	.....	133.67
Telephones and telegrams,	36.27	.....	36.27	148.37	.....	148.37
Traveling expenses, including attendance at agricultural fairs, farmers' meetings, educational conventions, trustees meetings	.....	.....	.....	.....	.....	.....
Printing, .....	.....	.....	.....	1023.48	.....	1023.48
Postage, .....	.....	.....	.....	730.66	.....	730.66
Office stationery and supplies, .....	.....	.....	.....	260.50	.....	260.50
Advertising, .....	.....	.....	.....	254.48	.....	254.48
Grove Cottage laundry and supplies, .....	.....	.....	.....	366.30	.....	366.30
Janitor work and supplies, .....	.....	.....	.....	126.94	1.15	128.09
Engineer, plumber and fireman, .....	.....	.....	.....	1441.70	41.13	1482.83
Board allowances as part salary, .....	.....	.....	.....	1551.36	.....	1551.36
Unclassified items, .....	.....	.....	.....	130.00	953.51	1083.51
	.....	.....	.....	171.90	.32	172.22
Cash balance Sept. 30, 1904,	80022.10	\$14981.90	95004.00	\$7006.85	14981.90	101987.75
Cash balance Sept. 30, 1905,	25099.92	.....	25099.92	18116.17	.....	18116.17
	105122.02	.....	120103.92	105122.02	.....	120103.92

HARTFORD, CONN., October 18, 1905.

This is to certify that we have examined the accounts of E. O. Smith, Treasurer of the Connecticut Agricultural College, for the year ending September 30, 1905, have compared the same with the vouchers therefor and found them correct.

The amount of cash in the hands of said Treasurer belonging to the State Fund at the opening of business October 1, 1905, was Four Hundred and One Dollars and six cents (\$401.06).

The amount of the "Morrill Fund" in the hands of said Treasurer at the opening of business, October 1, 1905, was Seventeen Thousand, Seven Hundred and Fourteen Dollars and seventeen cents (\$17,714.17).

The amount of the Land Grand Fund in the hands of said Treasurer at the opening of business October 1, 1905, was ninety-four cents (\$0.94).

The amount of the "Agricultural Experiment Station Fund" was Forty-four Dollars and forty-four cents (\$44.44).

JAMES P. BREE,
WILLIAM P. BAILEY,

*Auditors of
Public Accounts.*

CHAPTER XXXV

An Act concerning Reports of State Institutions

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. It shall be the duty of the officers of each institution and commission of this State, who are required by law to report to the Governor or to the General Assembly, to give, in the financial statement of receipts and expenditures contained in their respective reports, a detailed statement of the salaries paid to each and every officer and employee for the year ending with the 30th day of September next preceding.

SEC. 2. This act shall not apply to any officer or employee whose compensation is less than four hundred and fifty dollars per annum.

Approved, March 17, 1897.

SALARIES OF THE OFFICERS AND EMPLOYEES OF THE COLLEGE WHO RECEIVE MORE THAN FOUR HUNDRED AND FIFTY DOLLARS A YEAR, ARE PAID AT THE ANNUAL RATES, AND FROM THE COLLEGE FUNDS HERE NAMED:

From the Morrill Fund (United States Government grant of 1890):

L. A. Clinton (part salary)	\$1,500.00
A. G. Gulley	2,000.00
C. L. Beach (part salary)	1,600.00
Fred Mutchler	1,800.00
E. H. Lehnert	1,800.00
E. A. White	1,500.00
C. A. Wheeler	1,800.00
F. W. Putnam (part salary)	1,000.00
H. R. Monteith (part salary)	1,500.00
E. O. Smith (part salary)	1,200.00
H. E. Starr (part salary)	300.00
B. B. Turner (part salary)	1,400.00
Alberta T. Thomas (part salary)	1,000.00
Anna W. Brown (part salary)	600.00
W. A. Stocking, Jr. (part salary)	750.00
C. K. Graham (part salary)	573.06
E. D. Proudman (part salary)	900.00
H. L. Garrigus (part salary)	300.00
H. W. Conn	500.00
H. D. Edmond (part salary)	380.00

From the Land Grant Fund (United States Government grant of 1862):

Rufus W. Stimson	\$2,500.00
H. R. Monteith (part salary)	400.00
E. O. Smith (part salary)	300.00
H. E. Starr (part salary)	100.00
Edwina M. Whitney	700.00
E. D. Proudman (part salary)	600.00
E. R. Bennett (part salary)	200.00
Emma H. Koller (part salary)	500.00
Lena M. Gardner	600.00
Lillian E. Rogers	480.00

From the annual State appropriation:

F. W. Putnam (part salary)	\$500.00
H. L. Garrigus (part salary)	300.00
D. D. Kinne	600.00
J. N. Fitts	720.00
J. Hauschild	723.18
C. H. Copeland	540.00

The above detailed report of salaries is made in obedience to the Connecticut law reprinted on the previous page.



State of Connecticut.

PUBLIC DOCUMENT No. 34.

SEVENTEENTH ANNUAL REPORT

OF THE

STORRS

AGRICULTURAL EXPERIMENT STATION,

STORRS, CONN.

FOR THE YEAR ENDING JUNE 30, 1905.

PRINTED BY ORDER OF THE LEGISLATURE

**MIDDLETOWN, CONN.
FELTON & KING, PRINTERS AND BOOKBINDERS.
1906**

PUBLICATION
APPROVED BY
THE BOARD OF CONTROL.

BOARD OF CONTROL.

THE BOARD OF TRUSTEES

—OF THE—

CONNECTICUT AGRICULTURAL COLLEGE.

HIS EXCELLENCY GOVERNOR HENRY ROBERTS.

GEORGE S. PALMER, *V.-Pres.*,

E. H. JENKINS,

GEORGE A. HOPSON.

L. J. STORRS,

E. STEVENS HENRY,

D. WALTER PATTEN.

A. I. PIERPONT.

B. C. PATTERSON,

CHARLES A. CAPEN.

TREASURER.

E. O. SMITH, Storrs.

STATION COUNCIL

R. W. STIMSON, - - *President of the Connecticut Agricultural College.*

G. A. HOPSON, - - - - - *Appointed by Board of Trustees.*

L. A. CLINTON, - - - - - - - *Ex-officio as Director.*

A. G. GULLEY, - - - - - *Appointed by Station Staff.*

C. L. BEACH, - - - - - *Appointed by Station Staff.*

EXPERIMENTING STAFF.

L. A. CLINTON, - - - - - Director.

H. W. CONN, - - - - - *Supervisor Dairy Bacteriology.*

C. L. BEACH, - - - - - *Dairy Husbandman.*

B. B. TURNER, - - - - - *Chemist.*

C. K. GRAHAM, *Poultryman.*

W. A. STOCKING, JR., - - - - - *Assistant Bacteriologist.*

E. R. BENNETT, - - - - - *Assistant Horticulturist.*

H. L. GARRIGUS, - - - - - *Assistant Field Experimenter.*

CHARLES THOM, - - - - - *Cheese Expert, Mycologist.*

ARTHUR W. DOX, - - - - - *Cheese Expert, Chemist.*

THEODORE ISSAJEFF, - - - - - Cheese Maker.

H. D. EDMOND, *Assistant Chemist.*

CONSULTING STAFF.

A. G. GULLEY, - - - - - *Horticulture.*

E. A. WHITE, - - - - - *Botany.*

E. H. LEHNERT, - - - - - *Veterinary Science.*

Publications of the Station

AVAILABLE FOR FREE DISTRIBUTION.

THE STORRS AGRICULTURAL EXPERIMENT STATION is located in Mansfield Township, Tolland County, Connecticut, and is under the control of the Board of Trustees of the Connecticut Agricultural College. The freight and express station is Eagleville, Conn., on the Central Vermont Railroad. The telegraph address is Willimantic, with which city the Station is connected by telephone. Long distance telephone connection brings all points of the State into direct communication with the Station.

The following publications of the Storrs Agricultural Experiment Station are available for distribution, and, as long as the supply lasts, will be sent free to all who desire them.

All correspondence should be addressed to

STORRS AGRICULTURAL EXPERIMENT STATION,

STORRS, CONNECTICUT.

BULLETINS.

- No. 5. Atmospheric Nitrogen as Plant Food.
- No. 7. Chemistry and Economy of Food.
- No. 12. The Ripening of Cream by Artificial Bacteria Cultures.
- No. 14. The Elm Leaf Beetle.
- No. 20. A Study of Dairy Cows.
- No. 21. The Ripening of Cream.
- No. 23. The Relation of Bovine Tuberculosis to that of Man and its Significance in the Dairy Herd.
- No. 25. The Covered Pail a Factor in Sanitary Milk Production.
- No. 26. The Relation of Temperature to the Keeping Property of Milk.
- No. 27. Poultry as Food.
- No. 28. Dairy Observations.
- No. 29. Records of a Dairy Herd for Five Years.
- No. 30. Spraying Notes for 1903.
- No. 31. Food Value of a Pound of Milk Solids.
- No. 32. Protecting Cows from Flies.
- No. 33. A Successful Brooder House.

- No. 34. Discussion of the Amount of Protein Required in the Ration for Dairy Cows.
- No. 35. The Camembert Type of Soft Cheese in the United States.
- No. 36. Poultry Suggestions for the Amateur.
- No. 37. The So-called "Germicidal Property" of Milk.
- No. 38. The Marketing of Poultry Products.
- No. 39. Pig Feeding Experiments.
- No. 40. Creamery Problems.
- No. 41. Spraying Notes, 1904-1905.
- No. 42. Quality of Milk Affected by Common Dairy Practices.

REPORTS.

The Reports of the Storrs Agricultural Experiment Station for 1889, '90, '91, '94 (Part III.), '95 (Part III.), '96 (Part II.), '98, '99, 1900, 1901, 1902-3, 1904, 1905, are available for free distribution.

Address all requests to the Director of Storrs Agricultural Experiment Station, Storrs, Conn.

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Report of the Treasurer

FOR THE FISCAL YEAR ENDING JUNE 30TH, 1905.

The following summary of receipts and expenditures, made out in accordance with the form recommended by the United States Department of Agriculture, includes, first, the Government appropriation of \$7,500, and, secondly, the annual appropriation of \$1,800 made by the State of Connecticut, together with various supplemental receipts. These accounts have been duly audited according to law, as is shown by the Auditors' certificates, copies of which are appended.

GOVERNMENT APPROPRIATION—RECEIPTS AND EXPENDITURES

RECEIPTS	
United States Treasury, - - - - -	\$7,500 00
EXPENDITURES	
Salaries, - - - - -	\$3,544 14
Labor, - - - - -	1,528 78
Publications, - - - - -	192 10
Postage and stationery, - - - - -	164 08
Freight and express, - - - - -	68 87
Heat, light, water, and power, - - - - -	84 96
Chemical supplies, - - - - -	177 65
Seeds, plants, and sundry supplies, - - - - -	452 49
Feeding stuffs, - - - - -	314 24
Library, - - - - -	65 22
Tools, implements, and machinery, - - - - -	29 74
Furniture and fixtures, - - - - -	82 00
Scientific apparatus, - - - - -	21 76
Live stock, - - - - -	59 50
Traveling expenses, - - - - -	456 89
Contingent expenses, - - - - -	15 00
Buildings and repairs, - - - - -	242 68
	<u>\$7,500 00</u>

AUDITORS' CERTIFICATE

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Storrs Agricultural Experiment Station for the fiscal year ending June 30, 1905, that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been \$7,500 and the corresponding disbursements \$7,500, for all of which proper vouchers are on file and have been examined by us and found correct, thus leaving no balance.

And we further certify that the expenditures have been solely for the purposes set forth in the act of Congress approved March 2, 1887.

(Signed) GEO. A. HOPSON, }
 A. J. PIERPONT, } *Auditors*

STORRS, CONN., July 15, 1905.

STATE APPROPRIATION AND SUPPLEMENTAL RECEIPTS
RECEIPTS AND EXPENDITURES

RECEIPTS												
State of Connecticut,	-	-	-	-	-	-	-	-	-	-	-	\$1,800 00
Miscellaneous receipts,	-	-	-	-	-	-	-	-	-	-	-	684 31
												<u>\$2,484 31</u>
EXPENDITURES												
Salaries,	-	-	-	-	-	-	-	-	-	-	-	\$1,246 89
Labor,	-	-	-	-	-	-	-	-	-	-	-	139 79
Postage and stationery,	-	-	-	-	-	-	-	-	-	-	-	32 28
Freight and express,	-	-	-	-	-	-	-	-	-	-	-	50
Chemical supplies,	-	-	-	-	-	-	-	-	-	-	-	48 74
Seeds, plants, and sundry supplies,	-	-	-	-	-	-	-	-	-	-	-	278 15
Feeding stuffs,	-	-	-	-	-	-	-	-	-	-	-	36 80
Scientific apparatus,	-	-	-	-	-	-	-	-	-	-	-	58 50
Live Stock,	-	-	-	-	-	-	-	-	-	-	-	289 84
Traveling expenses,	-	-	-	-	-	-	-	-	-	-	-	33 89
Balance,	-	-	-	-	-	-	-	-	-	-	-	<u>818 95</u>
												<u>\$2,484 31</u>

AUDITORS' CERTIFICATE

We, the undersigned, duly appointed Auditors of the Corporation, do hereby certify that we have examined the books and accounts of the Storrs Agricultural Experiment Station for the fiscal year ending June 30, 1905, that we have found the same well kept and classified as above, and that the receipts for the year from the State of Connecticut are shown to have been \$1,800, and the receipts from miscellaneous sources \$684.31, making the total receipts from the State and miscellaneous sources \$2,484.31. The corresponding disbursements were \$2,165.36, for all of which proper vouchers are on file and have been by us examined and found to be correct, thus leaving a balance of \$318.95.

(Signed) GEO. A. HOPSON, }
 A. J. PIERPONT, } *Auditors*

STORRS, CONN., July 15, 1905.

E. O. SMITH, *Treasurer.*

Report of the Director.

During the past year the work of the Storrs Agricultural Experiment Station has proceeded along the same general lines as outlined in the report for the year ending June 30, 1904. There have been no radical changes in the policy of the Station and but few in the lines of the work taken up. We believe that as a matter of Station policy it is well to confine our experiments to a few definite lines, and in these lines to do thorough work until we have completed the investigations.

CHANGES IN THE STATION STAFF.

We have been especially fortunate during the past year in that we have not been compelled to make many changes in the working staff. Professor F. H. Stoneburn resigned his position as poultryman in College and Station, and the position has been filled by the appointment of Professor C. K. Graham.

Mr. A. W. Bosworth, who was engaged by the Department of Agriculture in our coöperative cheese investigations, resigned his position as chemist and has been succeeded by Mr. Arthur W. Dox.

COÖPERATION WITH THE U. S. DEPARTMENT OF AGRICULTURE.

Our work in coöperation with the United States Department of Agriculture has continued satisfactorily during the year. The special problems in the investigation of the manufacture of soft cheese are so difficult in their nature that some time certainly must elapse before we are able to reach definite conclusions. Consequently the progress of this work will be apparently slow. In spite of this fact definite advance has been made during the year. A preliminary bulletin has been published upon the subject of "The Camembert Type of Soft Cheese in the United States," and other bulletins on the same general subject are in course of preparation.

We have found that some of the varieties of soft cheese which are popular in this country as well as in Europe can be successfully manufactured here. The Camembert cheese which we have made has been pronounced by experts equal to the best European product in every way.

One factory has introduced the making of Camembert cheese as a result of our experiments in this line. Their cheese maker came here and spent several weeks in getting familiar with the details of manufacture, and they are now producing a first-class article, which is finding ready sale in the markets.

The next type of cheese which will receive attention is the Roquefort. There seems to be for this an even greater demand than for the Camembert type, and if, as a result of our experiments we make it possible to manufacture a good quality of Roquefort in America, it will certainly be a work which should bring credit to the Station and to the state.

The part of the state fund which has heretofore been used in the food nutrition investigations is now being used to conduct experiments in the manufacture of soft cheese.

POULTRY INVESTIGATIONS.

Under the direction of Professor C. K. Graham, the poultry experiments have been increased, and at the present time much interesting work is in progress. There is no department of our work which seems to appeal more directly to the general public than does our poultry investigation. Many who are interested in no other line of agriculture take special interest in poultry. The poultry bulletins which have been issued during the past year have been in great demand. Other bulletins will be issued during the coming year giving results of experiments in poultry work.

The experiments with squabs have been continued now for more than two years, and during the coming year these experiments may be concluded. Important data have been secured, and it seems unwise to expend further effort in this direction.

DAIRY HUSBANDRY.

Experiments along dairy lines have been in progress during the entire year, and the bulletins issued by this department are in wide demand. Bulletin No. 31, entitled "The Food Value

of a Pound of Milk Solids," has been issued in a special edition. One person desired 2,000 copies of this bulletin and was willing to pay all the expense of issuing the special edition.

The economical use of skim milk from the dairy herd has been a subject of investigation, experiments have been carried on with several lots of pigs, and a bulletin has been issued giving the results of these experiments.

DAIRY BACTERIOLOGY.

The production of clean and wholesome milk is receiving more attention each year. If milk is ever to take the place it should among our food products, it will do so in part as a result of this campaign for the production of milk under better conditions. A study has been made of the conditions actually existing in various dairy barns of the state, and the milk produced under these various conditions has been tested for the amount of dirt and the number of bacteria. The city milk inspectors and the boards of health are demanding that the milk which is supplied to the cities shall be of a higher grade than it has been in the past. The Station has endeavored to assist the producers of milk in this state in securing a better quality of milk, and this work has apparently met with appreciation on the part of our dairy farmers.

There is another side to the problem of pure milk production that has not yet received the attention it demands. If the consumers must have purer and better milk, they must realize that it costs more to produce such milk and that the dairymen must receive for this better product an increased price. Were this realized in all cases, it would be a much easier task to persuade the dairymen that the production of purer milk is to their advantage.

FIELD EXPERIMENTS.

Field experiments have been conducted along horticultural lines. The growing of vegetables under canvas has been tried for two seasons and will be discontinued during the coming season. The spraying of potatoes will be reported upon by the Assistant Horticulturist. But little of the land of the College farm is suited to general plot experiments. Observations are made upon the results secured by various methods of treating

the field crops, and while this gives us valuable information, it does not give us the definite data which would be required for publication.

STATION FINANCES.

The funds available for Station work have not been increased during the past year. We receive one-half of the Hatch appropriation, namely, \$7,500 annually, and \$1,800 a year from the state. The printing of the Station bulletins and annual reports is paid for by the State Treasurer out of state funds.

With the small amount of money available for Station work it seems wise to pursue the policy which we have adopted in the past, namely, to confine our attention to a few lines of work and do this work most thoroughly.

In carrying out this policy we have had the hearty coöperation of the Board of Trustees of the Connecticut Agricultural College and of those officers of the College who have in any way been associated with the Station and its work.

L. A. CLINTON.

Report of the Dairy Husbandman.

To the Director of the Storrs Agricultural Experiment Station:

SIR:—I herewith submit a brief outline of the work in the dairy department during the past year.

FEED TRIALS WITH PIGS.

During the past year twelve lots of pigs have been fed skim milk and middlings. When fed in the proportion of one of middlings to four of milk, the cost of 100 pounds of gain was \$4.45. When fed in the proportion of one of grain to eight of milk, the cost of 100 pounds of gain was \$4.95.

CREAMERY PROBLEMS.

Samples of skim milk from hand separators and Cooley creamers have been collected and tested with the Babcock test. Pure cultures have been used in ripening cream, and the quality of butter has been compared with that made from cream ripened with skim milk starters. A large number of samples of cream have been tested, and a comparison has been made of the results of weighing and measuring samples.

FEEDING TRIALS WITH COWS.

An experiment was undertaken to show the value of nutrients in concentrates compared with the nutrients in roughages. Two dry cows of the same age and condition were fed a maintenance ration for a period of 100 days. Fifteen pounds of hay containing 7.4 pounds of dry matter were found to be equivalent to 6 pounds of corn meal containing 4.3 pounds of dry matter. The difference in the value of nutrients in grain and hay is attributed to a difference in the energy required for digestion. A similar trial with milch cows is also reported.

Blatchford's calf meal was fed to calves, and its feeding value was compared with that of skim milk. Exclusive of hay and grain eaten, 1 pound of gain in live weight was made from 1.09 pounds of nutrients in milk, while with the calf meal 1.79 pounds of nutrients were required for 1 pound of gain.

Respectfully submitted,

C. L. BEACH.

Report of the Poultryman.

... —

To the Director of the Storrs Agricultural Experiment Station:

SIR:—The six months during which I have been connected with your Station has hardly been time enough to secure results in any research work, although considerable has been done.

While investigations into the squab industry are taking a large portion of my time, still a number of other experiments are receiving attention.

The hopper system of feeding, both with young chicks and laying hens, is being tested in all its branches; that is, by different feeds and with hens in confinement and on free range. The question of minimum cost of housing and feeding poultry is also being tested.

There have been a great many inquiries from all parts of the state regarding sick fowls, and eighty-three birds have been sent to the department for examination. In a great many of these cases satisfactory information was furnished to the persons concerned, but in a few cases it was thought advisable to visit the "plants." In every case but one where the plant was visited the trouble could be traced to improper care. The one exception was a case of poisoning.

Respectfully submitted,

C. K. GRAHAM.

Report of the Chemist.

To the Director of the Storrs Agricultural Experiment Station:

SIR:—During the summer of 1904 I utilized a considerable part of my vacation in studying the chemistry of proteolytic changes and products in Strassburg under Professor Franz Hofmeister, with special reference to the work being carried on here in making soft cheeses. This experience has been of inestimable advantage to me in advising upon this work.

In June, 1905, Mr. A. W. Bosworth, B. S., resigned his position as chemical cheese expert. Mr. A. W. Dox, B. S. (Univ. of Pa.), A. M. (Columbia), has been appointed in his place. Mr. H. D. Edmond has rendered valuable help in the work of this department since his appointment as assistant in the College in November, 1904, and is now recognized as an assistant chemist to the Experiment Station.

Apart from the special cheese investigation to which Mr. Bosworth devoted his time, most of the chemical work has been done in connection with experiments in other departments and is therefore considered elsewhere. Analyses have been made by the Station chemist and assistant of milks, feeds, fertilizers, manures (for digestion experiments), cheeses (determination of different classes of nitrogen compounds), suspected foods and stomach contents (qualitative tests for poisons), air (determination of carbon dioxide), rocks, etc. Preliminary work, which is not yet in a stage to report, has been done along three lines: (1) the nature of the flavoring substances in Roquefort cheese; (2) the connection between soil fertility and analyses by special methods of extraction; and (3) the growth of the potato plant and the quality of its tubers. Pot experiments in connection with the last two were carried on this season (1905). This work will necessarily extend over a considerable time.

The equipment of the department has been liberal enough to free the work from any great trouble on that score. We are sadly cramped for room, however, three men having to work in a space barely sufficient for one. An addition to our laboratory space of at least one other good-sized room is urgently required if the growing needs of the work are to be met.

Respectfully submitted,

B. B. TURNER.

Report of the Bacteriologist.

— ... —

To the Director of the Storrs Agricultural Experiment Station:

SIR:—A number of lines of bacteriological work have been conducted by this department during the year ended June 30, 1905. Some of these are continuations of investigations which were begun before the beginning of the year. Certain of these investigations have progressed sufficiently to be reported upon, and the results obtained will be found elsewhere in this report. Some of the more technical lines of work which have been running for some years are still incomplete, and no report will be given at present. During the year a number of special problems have been investigated. Some of these will be reported in this volume, while certain others are still in process of investigation, and not sufficiently completed to warrant a report at this time.

The bacteriological and sanitary studies of market milk mentioned in my last report have occupied a considerable amount of time during the year, and sufficient results to warrant publication have been obtained from two series of investigations. The purpose of this work is to obtain more definite knowledge in regard to the sanitary condition of milk produced by the dairymen of the state; and in this work not only the milk but the stable conditions of the dairies have been studied, with the results given in the article entitled "Studies of Market Milk" found in this report. In view of the present agitation on the part of city officials and the general public toward a cleaner milk supply, it is of great importance to know definitely the quality of the milk when it leaves the hands of the producer. While the results given in the present article indicate the quality of the milk produced by dairymen in two localities, the writer believes that they are not representative of many sections of our state, and intends to continue this line of investigation in other sections.

During the year a considerable number of samples of milk and cream have been sent to this department by dairymen and dealers in various parts of the state. These have been tested, and reports given to those sending the samples. Several dairymen in the eastern part of the state who are sending milk to Boston have had their milk condemned by the Boston milk officials because of its too great germ content. A number of these men have applied to the Station for help, and the writer has visited some farms, giving suggestions in regard to methods of cleanliness in the stables, which have resulted in the milk's being again accepted by the Boston authorities.

In coöperation with the dairy division a series of bacteriological studies was made in connection with the use of different butter starters. The results of this work are reported by Professor Beach.

The bacteriological work in connection with the soft cheese problems has been continued from the previous year, and considerable work in these lines has been done during the year.

An extended series of experiments is being made to determine the effect of stable conditions and of various methods of milking upon the germ content, keeping quality, and sanitary condition of milk. This work is not yet completed, but a report upon the results thus far obtained is given in this report. The work, however, will be continued.

Respectfully submitted,

W. A. STOCKING, JR.

Report of Supervising Bacteriologist.

— ... —

To the Director of the Storrs Agricultural Experiment Station:

The bacteriological work of the Station the last year has comprised several series of experiments. A part of these have been carried out under the direction of Mr. W. A. Stocking and are reported by him in another part of this report. The work done under my own personal direction has been conducted partly at Storrs and partly at Middletown. This work has comprised two lines of investigation.

1. The work undertaken by the Station upon Camembert cheese has involved a considerable amount of bacteriological study. While it has become abundantly proved that the chief agent in the ripening of these cheeses is a mold, it has been also clear that bacteria play an important and necessary part in this ripening. Exactly what their agency is it has been difficult to determine, and it has hitherto not been understood. A large number of cheeses of our own make, of cheeses bought in the market, and of cheeses imported especially from Europe for our work have been subjected to bacteriological analysis. A part of the results have already been published in Bulletin No. 35, and a fuller report will appear later. The essential result of this work is to show that the only bacteria necessary to the ripening of the cheese are the common lactic bacteria. Ideally ripened Camemberts have been found containing, at least within the rind, no other varieties of bacteria. When other species are present various kinds of abnormal ripening are usually the result.

2. The second line of investigation, far more extensive than the first, has been upon the systematic study and classification of dairy bacteria. This work was begun several years ago and has involved a large amount of labor. Hundreds of varieties of bacteria from different sections of the country, as well as from Europe, have been studied. The work has progressed so

far as to render it desirable to publish the results. But the American Society of Bacteriologists are planning to adopt during the present year a uniform scheme for bacteriological description. It would be useless to publish our descriptions until after this uniform plan has been decided upon. It has been thought best, therefore, to continue the work during the present year, both for the purpose of obtaining more data before publication, and in order that the descriptions, when published, may conform to the plan adopted by the Bacteriological Society. It is expected that this work will be published in the next annual report.

Respectfully submitted,

H. W. CONN

Report of the Mycologist.

— ... —

To the Director of the Storrs Agricultural Experiment Station:

SIR:—The mycologist of the soft cheese investigation has continued the work outlined in the first report. The special studies upon the mycology of Camembert have been already briefly reviewed in Bulletin 35 of this Station. A detailed paper covering the technical part of the work done is now nearly completed. This will present the results of the work already done upon Roquefort cheese as well as upon Camembert. There will also be a brief review of mycological examinations of the other types of soft cheese found upon the American market. These and related lines of experiment and study are being continued. The study of the dairy molds in general has led to the proposal of methods of description for this type of organisms based upon their relation to standard culture media. This series of studies was reviewed before the meeting of the American Mycological Society at the December meeting, 1904. The study and collection of the species of the genus *penicillium* has brought out many interesting forms, but the work is still too far from completion to present it for publication at this time.

Respectfully submitted,

CHARLES THOM.

Report of the Assistant Horticulturist.

To the Director of the Storrs Agricultural Experiment Station:

SIR:—The work in this department is being carried on along practically the same lines as last year.

1. Four plots of potatoes are being grown for the purpose of determining the minimum number of applications of Bordeaux that will prevent potato rot.
2. Plots of cucumbers and melons have been planted for the study of melon blight.
3. The cultural and spraying experiment with tomatoes made last year is being repeated this season.
4. The ground shaded with cloth has been planted to vegetables with duplicates outside, the same as last year.
5. During the winter asparagus and rhubarb growing in the cellar was tried.
6. An experiment to determine the relative value of pistillate and staminate asparagus plants has been made.

The results of these six experiments are given in this report.

An apple orchard of 125 trees has been planted on rough waste land to determine whether land that is too rough to plow can be utilized to advantage in orcharding.

A number of market gardens and orchards have been visited in studying plant diseases and the market garden industry of the state.

Respectfully submitted,

E. R. BENNETT.

TESTING COWS FOR ADVANCED REGISTRY.

BY C. L. BEACH.

The admission of dairy cattle to advanced registration is based upon production. For a mature cow (five years old or more) the requirement for the year's record is a yield of not less than 500 pounds of butter, 400 pounds of fat, or 10,000 pounds of milk for the Jersey; 360 pounds of fat for the Guernsey; 8,500 pounds of milk and 375 estimated butter for the Ayrshire; and 10,700 pounds of milk and 375 of butter for the Holstein. The requirements for admission in the two-year form are from 60 to 70 per cent. of those in the full age form, and for animals between two and five years old they are in proportion to age.

TABLE 1.

Robin Butterfly, 3rd, A. J. C. C. No. 187,089. Age, 2 years and 8 days. Owned by Connecticut Agricultural College.

MONTH.	Lbs. Milk.	Per Cent. Fat.	Lbs. Fat.	Estimated Lbs. of Butter.
October 13-31, - - - - -	302.8	5.8	17.56	20.48
November, - - - - -	399.2	6.6	26.34	30.73
December, - - - - -	405.6	6.8	27.58	32.17
January, - - - - -	373.7	6.5	24.29	28.34
February, - - - - -	330.6	6.4	21.15	24.68
March, - - - - -	358.7	7.6	27.26	31.80
April, - - - - -	316.2	6.4	20.23	23.60
May, - - - - -	382.7	5.4	20.66	24.10
June, - - - - -	441.7	6.5	28.71	33.50
July, - - - - -	389.2	6.3	24.51	28.60
August, - - - - -	353.6	6.4	22.63	26.40
September, - - - - -	387.1	7.3	28.25	32.96
October 1-12, - - - - -	49.9	7.3	3.64	4.25
	4491.0	—	292.81	341.61

The records of six cows here given exceed the requirements of the advanced registry of the respective cattle clubs, and conform to the rules by which such tests are made except as to the method of certification. These six animals are owned, and four of them were bred, by the Connecticut Agricultural College:

ROBIN BUTTERFLY, 3D.

Robin Butterfly, 3rd, was 2 years 8 days old at the beginning of the test. Feed consumed during the year, 1,139 pounds of hay, 7,025 pounds of silage, 1,665 pounds of grain, with 126 days at pasture. Record for the year, 293 pounds of fat. Requirements for admission to Registry of Merit, 260 pounds of fat (see Table 1, page 24).

ROBIN BUTTERFLY, 2D.

Robin Butterfly, 2nd, was 2 years and 149 days old at the beginning of the test. Feed consumed during the year, 511 pounds of corn stover, 575 pounds of hay, 7,944 pounds of corn silage, 1,116 pounds of grain, 126 days at pasture. Record for the year, 292 pounds of fat. Requirements for admission to Registry of Merit (when less than 30 months old) 260 pounds of butter fat.

TABLE 2.

Robin Butterfly, 2d, A. J. C. C. No. 162,567, Age 2 years and 149 days. Owned by Connecticut Agricultural College.

MONTH.	Lbs. of Milk.	Per Cent. of Fat.	Lbs. of Fat.	Estimated Lbs. of Butter.
May 28 to 31, - - - - -	11.5	7.2	.82	.95
June, - - - - -	283.2	5.0	14.16	16.52
July, - - - - -	560.9	5.1	28.60	33.36
August, - - - - -	504.9	5.45	27.51	32.10
September, - - - - -	532.2	5.65	30.06	35.07
October, - - - - -	407.3	6.6	26.68	31.13
November, - - - - -	351.3	6.4	22.48	26.23
December, - - - - -	360.2	6.9	24.85	28.99
January, - - - - -	406.5	6.6	26.82	31.29
February, - - - - -	302.0	6.77	20.44	23.85
March, - - - - -	354.8	6.3	22.35	26.07
April, - - - - -	340.1	6.3	21.42	24.99
May 1 to 27, - - - - -	347.3	7.5	26.04	30.38
	4762.2	—	292.23	340.93

Robin Butterfly, 2nd, is full sister to Robin Butterfly, 3rd, with record of 293 pounds of butter fat at two years of age; daughter of Robin Butterfly, with record of 463 pounds of fat; and granddaughter of Butterfly Maid, with record of 15.37 pounds of butter in seven days.

STILETTO.

Age of cow at beginning of test, 3 years and 39 days. Requirements for admission to Advanced Registry, 6,607 pounds of milk and 280 pounds of butter. Record for the year, 6,707 pounds of milk and 307 pounds of butter. Feed consumed during year, 1,929 pounds of hay, 9,100 pounds of silage, 1,902 pounds of grain, 119 days at pasture.

TABLE 3.

Stiletto, Ayrshire Herd Record No. 16,706, Age of Cow, 3 years and 39 days. Owned by Connecticut Agricultural College.

MONTH.	Lbs. of Milk.	Per Cent. of Fat.	Lbs. of Fat.	Estimated Lbs. of Butter.
October 23-31, - - - - -	252.1	3.8	9.58	11.17
November, - - - - -	761.6	3.9	29.70	34.65
December, - - - - -	727.3	4.2	30.54	35.64
January, - - - - -	682.2	4.1	27.97	32.63
February, - - - - -	587.8	3.9	22.93	26.75
March, - - - - -	572.8	4.0	22.91	26.73
April, - - - - -	481.4	3.9	18.77	21.91
May, - - - - -	497.3	3.6	18.30	21.35
June, - - - - -	549.5	3.6	19.78	23.07
July, - - - - -	462.3	3.2	14.79	17.25
August, - - - - -	479.8	4.8	23.03	26.87
September, - - - - -	453.5	3.9	17.68	20.63
October 1-22, - - - - -	199.5	3.6	7.18	8.37
	6707.1	—	263.16	307.02

POLLY OF MAUCHLINE.

Polly of Mauchline is an imported Ayrshire cow. She consumed during the year, in addition to pasture, 1,460 pounds of hay, 10,665 pounds silage, and 2,872 pounds of grain. Record for the year, 9,322 pounds of milk and 425 pounds of butter. Requirements for admission to advanced Registry, 8,500 pounds of milk and 375 pounds of butter.

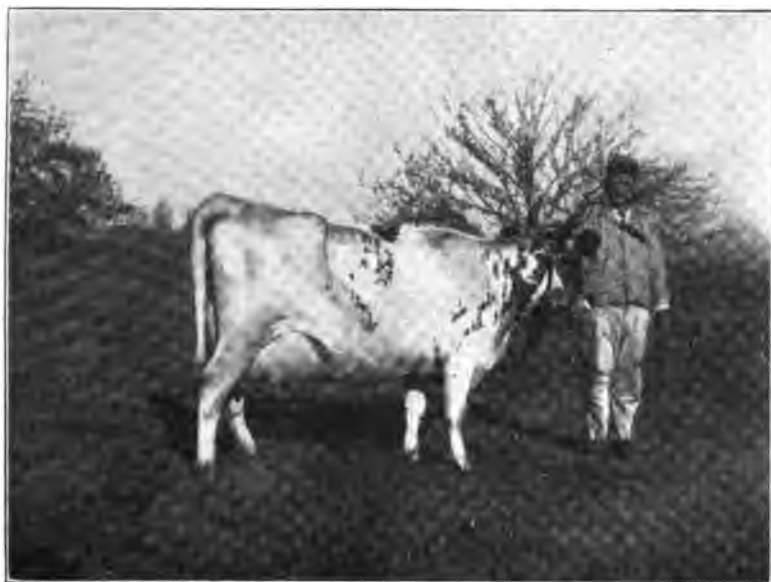


FIG. 1.—Polly of Mauchline, A. H. R. No. 12,294.
Record for one year: 9,322 pounds of milk; 425 pounds of butter.

TABLE 4.

Polly of Mauchline, Ayrshire Herd Book No. 12,294. Age, 6 years. Owned by Connecticut Agricultural College.

MONTH.	Lbs. of Milk.	Per Cent. of Fat.	Lbs. of Fat.	Estimated Lbs. of Butter.
November 5-30, - - - - -	994.2	3.8	37.77	44.06
December, - - - - -	1084.7	3.6	39.04	45.54
January, - - - - -	1190.2	4.1	48.79	56.92
February, - - - - -	1084.6	4.2	45.55	53.14
March, - - - - -	788.3	4.1	32.32	37.70
April, - - - - -	724.8	4.0	28.99	33.82
May, - - - - -	710.9	3.6	25.59	29.85
June, - - - - -	793.4	3.5	27.76	32.38
July, - - - - -	612.3	3.8	23.26	27.13
August, - - - - -	506.1	3.8	19.23	22.43
September, - - - - -	385.0	4.5	17.32	20.20
October, - - - - -	393.9	4.3	16.93	19.75
November 1-4, - - - - -	53.9	4.3	2.31	2.69
	9322.3	—	364.86	425.61

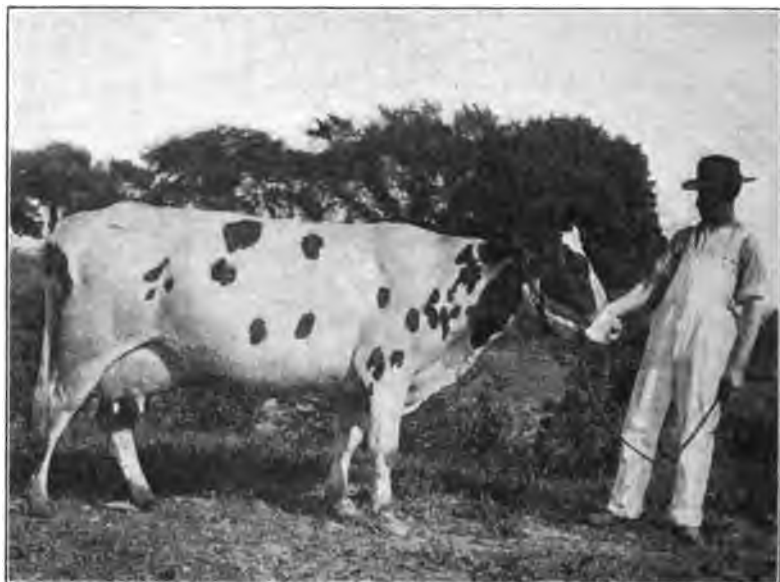


FIG. 2.—Altoana Pieterlje A., H. F. R. No. 54,656.
Record for one year: 13,050 pounds of milk; 527 pounds of butter.

TABLE 5.

*Altoana Pieterlje A, Holstein Friesian Registry No. 54,656.
Age 6 years. Owned by the Connecticut
Agricultural College.*

MONTH.	Lbs. of milk.	Per Cent. of Fat.	Lbs. of Fat.	Estimated Lbs. of Butter.
December 15-31, - - - - -	639.0	3.4	21.72	25.34
January, - - - - -	1533.9	3.6	55.22	64.42
February, - - - - -	1363.2	4.6	62.70	73.16
March, - - - - -	1447.4	3.4	49.21	57.41
April, - - - - -	1374.4	3.2	43.98	51.31
May, - - - - -	1486.5	3.2	47.56	55.48
June, - - - - -	1240.5	3.0	37.21	43.41
July, - - - - -	929.0	2.8	26.01	30.34
August, - - - - -	890.0	3.2	28.48	33.22
September, - - - - -	844.2	2.1	26.10	30.45
October, - - - - -	624.1	3.6	22.48	26.24
November, - - - - -	489.0	4.6	22.49	26.24
December 1-14, - - - - -	191.2	4.6	8.79	10.25
	13050.4	—	451.95	527.27

ALTOANA PIETERTJE A.

Altoana Pietertje A is a Holstein cow, 6 years old. She consumed during the year 1,487 pounds of hay, 11,820 pounds silage, 3,752 pounds of grain, and was at pasture 105 days. Record for year, 13,050 pounds of milk and 452 pounds of fat. Required for admission to Advanced Registry, 10,700 pounds of milk.



FIG. 3.—Eurotas, 2d, A. G. C. C. No. 14,067.

Age, 3 years and 234 days. Owned by Connecticut Agricultural College.

EUROTAS, 2D.

Eurotas, 2nd, is a Guernsey heifer, 3 years and 234 days old at the beginning of the test. She consumed during the year 1,087 pounds of hay, 7,895 pounds of silage, 2,500 pounds of grain, and was at pasture 105 days. Yield of butter fat for year, 332.5 pounds. Requirements for admission to Advanced Registry, 310.4 pounds of butter fat.

TABLE 6.

Eurotas, 2nd, A. G. C. C. No. 14,067, Age, 3 years and 234 days. Owned by Connecticut Agricultural College.

MONTH.	Lbs. of Milk.	Per Cent. of Fat.	Lbs. of Fat.	Estimated Lbs. of Butter.
January 12-31, - - - - -	487.3	5.3	25.82	30.12
February, - - - - -	696.8	4.2	29.26	34.14
March, - - - - -	739.9	4.7	34.77	40.56
April, - - - - -	665.1	4.2	27.93	32.59
May, - - - - -	706.5	4.7	33.20	38.73
June, - - - - -	681.8	4.4	29.99	34.99
July, - - - - -	642.2	4.6	29.54	34.46
August, - - - - -	631.3	4.6	29.03	33.87
September, - - - - -	649.7	4.9	31.83	37.13
October, - - - - -	560.1	5.0	28.00	32.67
November, - - - - -	412.3	4.5	18.55	21.64
December, - - - - -	237.7	5.2	12.36	14.42
January 1-11, - - - - -	42.5	5.2	2.21	2.58
	7153.2	—	332.49	387.88

In coöperation with the Ayrshire association, four cows owned by H. Dorrance of Plainfield, Conn., were tested for the Advanced Registry.

The milk from each cow for each milking was weighed and recorded by the owner. Once each month samples of milk were sent to the Station for the Babcock test. Three times during the year a representative of the Station visited the farm, weighed the milk, and collected samples for a check test. The records of the four cows are given in the table:

TABLE 7.

Herd of H. Dorrance, Plainfield, Conn.

NAME OF COW.	Herd Book No.	AGE OF COW AT BEGINNING OF TEST.			REQUIREMENTS FOR AGE.		RECORD OF COW.		
		Yrs.	Mos.	Days.	Lbs. of Milk.	Lbs. of Fat.	Lbs. of Milk.	Per cent. of Fat.	Lbs. Butter.
Molly Fryer, - -	16,051	6	8	8	8500	375	9741	4.02	453
Ruby Russel, - -	15,564	6	2	23	8500	375	8643	3.78	382
Dorris Y., - -	16,351	3	7	5	7086	305	7807	4.10	365
Dolly Fryer, 2nd, -	17,004	2	7	17	6118	256	6485	4.03	299

RECORD OF FIVE DAIRY HERDS.¹

In coöperation with the owners, the Station has secured the milk and fat records for one year of the individual cows in five herds. The Station furnished the milk sheets, loaned the milk scales, and collected and tested the samples. The owners of the herds weighed and recorded the amount yielded by each cow, and once each month took a composite sample of six milkings.

TABLE 8.

Milk and Butter Fat Yields of Five Herds.

	No. 1.		No. 2.		No. 3.		No. 4.		No. 5.	
	Lbs. of Milk.	Lbs. of Fat.	Lbs. of Milk.	Lbs. of Fat.	Lbs. of Milk.	Lbs. of Fat.	Lbs. of Milk.	Lbs. of Fat.	Lbs. of Milk.	Lbs. of Fat.
1. -	5496	272	5686	289	5627	344	6418	307	7157	421
2. -	3605	225	4731	260	5745	311	5330	287	6939	418
3. -	4665	212	5731	235	5387	297	6046	286	4589	290
4. -	4271	199	3802	230	5644	292	5291	277	4548	264
5. -	3410	198	4146	229	6209	285	5124	255	4452	264
6. -	2453	190	4233	225	5866	284	4245	253	4030	259
7. -	2979	189	3619	223	5347	274	—	—	—	—
8. -	3333	179	4721	222	4832	267	—	—	—	—
9. -	3193	165	4394	215	8165	262	—	—	—	—
10. -	2999	163	4078	205	3942	251	—	—	—	—
11. -	2582	151	3057	192	4348	247	—	—	—	—
12. -	2701	135	3131	150	4485	230	—	—	—	—
13. -	—	—	—	—	5285	228	—	—	—	—
14. -	—	—	—	—	4027	225	—	—	—	—
15. -	—	—	—	—	4050	211	—	—	—	—
16. -	—	—	—	—	4444	207	—	—	—	—
17. -	—	—	—	—	4084	204	—	—	—	—
18. -	—	—	—	—	3799	198	—	—	—	—
19. -	—	—	—	—	3557	193	—	—	—	—
20. -	—	—	—	—	3989	180	—	—	—	—
21. -	—	—	—	—	3400	177	—	—	—	—
22. -	—	—	—	—	2536	129	—	—	—	—
	3474	190	4277	223	4762	241	5409	278	5286	319

The individual production of butter fat ranged in herd No. 1 from 135 pounds to 272 pounds; in herd No. 2 from 150 pounds to 289 pounds; in herd No. 3 from 129 pounds to 344 pounds; in herd No. 4 from 253 pounds to 307 pounds; and in herd No. 5 from 259 pounds to 421 pounds.

The average production of butter fat ranged from 190 pounds in herd No. 1 to 319 pounds in herd No. 5. The difference in the average production of these two herds might be attributed in part to a difference in feeding, care, and management. In the opinion of the writer, however, the variance in a large measure was due to the difference in the breeding and the individuality of the cows in the two herds.

Dividing the herds into three divisions according to productive capacity, we have the following table:

TABLE 9.
Butter Fat Yield of Five Herds.

NO. OF HERD.							BEST COWS.		MEDIUM COWS.		POOREST COWS.	
							No. of Cows.	Average Fat Production.	No. of Cows.	Average Fat Production.	No. of Cows.	Average Fat Production.
1.	-	-	-	-	-	-	4	227	4	189	4	154
2.	-	-	-	-	-	-	4	254	4	225	4	190
3.	-	-	-	-	-	-	7	298	7	244	8	214
4.	-	-	-	-	-	-	2	297	2	281	2	254
5.	-	-	-	-	-	-	2	419	2	277	2	261
—							—	299	—	243	—	215

POULTRY SUGGESTIONS FOR THE AMATEUR.

BY C. K. GRAHAM.

- ... -

INTRODUCTION.

Many people raise a few chicks for their own use, while others grow a few broilers for the local market, but not enough to justify them in investing the money necessary to equip a model poultry plant. A few months ago a bulletin was issued by this Station setting forth the particulars of a model brooder house.

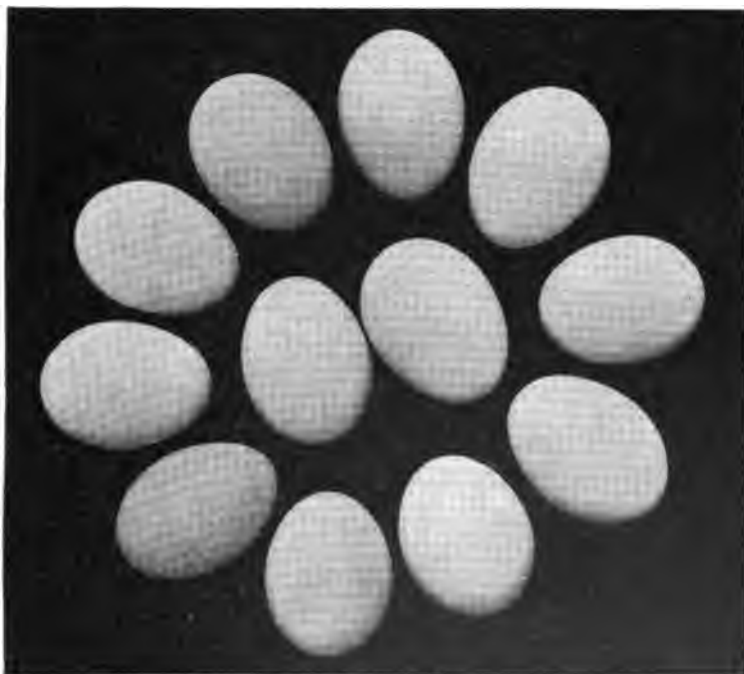


FIG. 4.—A fair sitting of eggs.

Its publication has brought in many inquiries for a brooder that will cost less and yet give satisfactory results to the small producer. This bulletin is published to answer some of the

questions received. It is not intended to give the results of experiments, but to assist the amateur who desires to keep a few chicks for pleasure as well as for profit.

Selecting Eggs for Hatching.—Money should in every case accompany orders for eggs. The shipper may be expected to give fair sized, smooth eggs from healthy birds. During the breeding season frequent complaints of unfair treatment in this respect are received. Investigation shows that the most of these spring from ignorance of what a good sitting of eggs is.



FIG. 5.—Some eggs that should be avoided when selecting for hatching.

Fig. 4 shows a fair sitting; while Fig. 5 shows a few eggs which should be avoided. Rough shelled, dirty, and mottled eggs with thin shells should also be excluded.

Small Eggs.—There is some doubt as to the advisability of setting small eggs. While it is possible that they may be as fertile and produce as many chicks as larger eggs, it is probable that pullets from the former will have a tendency to lay small eggs. For this reason, if for no other, shippers should avoid sending out small eggs, since they are likely to injure the reputation of the breed in the locality where they are sent.

Age of Eggs.—It is not advisable to buy eggs which are over five days old when shipped. Every egg should be carefully dated when taken from the nest in order to avoid error on this point. While good hatches have been secured from eggs that were three weeks old when placed in the incubator, as a rule they cannot be expected to hatch well after they are ten days old.

Packing Eggs for Hatching.—Too much care cannot be taken in packing. Fig. 6 shows a properly prepared package. There are two classes of general express, viz.: box, and handle packages. The former are likely to be thrown; while the latter are always carried. An ordinary basket with plenty of excelsior



FIG. 6.—Eggs ready for shipment. The baskets on the left show the method of wrapping each egg.

in the bottom, and sides well cushioned, makes an excellent receptacle. Into this the eggs, carefully wrapped, should be packed, and over them plenty of padding placed. Cheese cloth or cotton tacked over the top forms a satisfactory covering. Such a package, conspicuously labeled "*Eggs for Hatching*," can be shipped any distance and will reach its destination in good condition. Upon receipt of the package the eggs should not be removed until the hen or incubator is ready to receive them; but the basket should be turned over daily.

Sitting Hens.—Almost any broody hen can be made to sit if carefully handled. She should not be carried by the legs with her head hanging down, but with her breast resting in the palm of the hand. Transfer should be made at night, and the nest into which she is put kept dark for twenty-four or thirty-six hours.

Dusting Sitting Hens.—A sitting hen should be carefully but thoroughly dusted when first put upon the nest and twice thereafter, the last time being about the nineteenth or twentieth day.

Nests for Sitting Hens.—Fig. 7 shows a very simple house or series of nests for sitting hens. The nest may be kept dark



FIG. 7.—Front view of nests and runs used for sitting hens.



FIG. 8.—Rear view of nests with back removed to show the hen sitting.

by closing the door in front. The walk is about four feet long and as wide as the nest. A series of three nests makes a width of four feet, so that ordinary lath may be used for the top and ends of the walk. Fig. 8 shows the same nest box with the back taken off and the interior disclosed.

Rearing Incubator Chicks by Broody Hens.—A hen to which incubator chicks are to be given should be free from lice and in a nest where other hens cannot disturb her. In the evening two or three chicks, at least thirty-six hours old, may be placed under her from behind, care being taken not to excite her, lest she step on them. At least one chick of each color should be



FIG. 9.—Row of coops used for hens with chicks for first week.



FIG. 10.—Coop for hen and chicks after first week.

given her, for hens are apt to kill chickens of another breed, color, or size than those they have already adopted. The following morning she may be expected to mother as many as are given her.

The first week is the most critical period in the life of the chick. Trouble is most likely to be caused by chills. Fig. 9 shows a row of coops that have proved very satisfactory.

They are about two feet square, and have a six-inch board along the front so that the chicks cannot get away from the mother. As soon as they are lively enough to fly over this board they are moved to a coop such as is shown in Fig. 10, where they may have free range. The slat coop in front affords the hen opportunity for exercise. This coop is about thirty inches square and two feet high in the center. The floor draws out and can be easily cleaned, while the door in front excludes intruders at night. Ventilation is secured by a few small holes in the ends. The slat yard is made of four foot lath. One end is closed, the other fitted to the end of the small coop. It is not advisable to allow the hen free range for at least two weeks. If she is kept confined and fed coarse grains, while the chicks are being fed a few yards away on finer grains, she will soon forget to call them and probably will start to lay in three or four weeks, and at the same time will continue to protect the chicks during nights and unpleasant weather. If the chicks are to be distributed among several hens, it will be advisable to make colonies, care being taken to put those of about the same age together. Chicks of different ages should not be fed together, since the smaller ones will be crowded from the grain and will not thrive.

Rearing Chicks with Brooders.—Many people prefer the artificial method of raising chicks, but want "something cheap." It is not always wise, however, to use the "cheapest." Fig. 11 shows a brooder made out of an old packing case. A similar one which will accommodate fifty chicks can be built for about a dollar. This brooder has given excellent results, but must be used in a shed or colony house. The brooder proper is made of four ten-inch boards, three feet long, on which is nailed a tin or galvanized iron cover. Above this, around the sides, are strips one inch thick, and on these strips sits the floor of the brooder. There should be a couple of one-inch holes in each strip to admit air. The floor should be made of matched lumber. In the center an eight-inch hole should be cut, and over this an old tin pan, about ten inches across at the top (which is now to become the bottom) and four inches deep, should be placed. The sides of this tin should be punched full of holes. For a hover a table two feet six inches square, with

legs about four and one-half inches long, may be used. Cheap felt may be tacked on for a curtain, care being taken that it is cut from top to bottom every five or six inches. For an outside wall four four-inch strips, three feet long, nailed together,

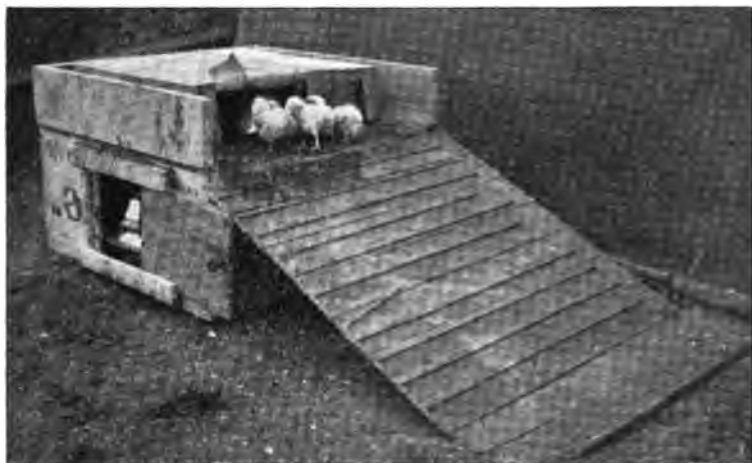


FIG. 11.—Home made brooder.

and set on the brooder, will be satisfactory. When the chicks are ten days old, one side may be taken away, and a bridge used so that they may run from under the hover direct to the floor of the room. Fig. 14 shows the lamp used in this brooder. The

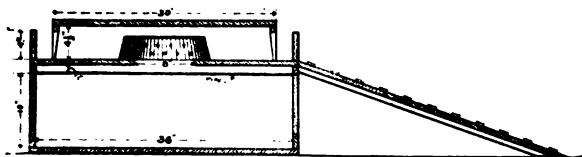


FIG. 12.—Cross section of home made brooder house.

burner can be bought for twenty-five cents, and the bowl may be made of a two-quart tin basin covered with a small pie plate turned bottom side up. This plate should have a hole punched in it and should be fastened to the collar of the burner with a drop of solder. It is also advisable to fasten the plate to the basin in the same way.

Winter Chicks.—Fig. 13 shows a brooder in which thirty chicks have been housed since Feb. 1st of this year, and in spite of more or less zero temperature there has been little difficulty in keeping the thermometer above ninety degrees. The records show that although it stood in an open field all the time, it consumed only about a pint of oil a day during the first two months. This style of brooder can be bought of almost any incubator firm for from twelve to sixteen dollars. It is supposed to accommodate fifty chicks, but during the season



FIG. 13.—A brooder suitable for winter weather, as well as for summer.

when the snow is on the ground and the chicks necessarily confined, it may be wise to limit the number to twenty-five or thirty. Yet, if after the first two weeks the chicks can get out on the ground, fifty can be easily accommodated. By utilizing such means as have been described one may be sure of raising a few early broilers. If the future poultryman will only "go slow" and practice in a small way before taking up the work as a business, he will be in much better shape to compete in our markets, and failures in poultrydom will decrease fully seventy-five per cent.

Care of Young Chicks.—In order to have a good, early maturing pullet it is necessary that she get a good start. The first few weeks' care is responsible to a great extent for her success or failure eight months later. Feed, regularity of feeding, cleanliness, and plenty of grit and water are all important matters. Chicks should be carefully protected from storms and sudden changes of weather, since these together with the low vitality of the parent are responsible for more deaths than is improper food. Poultrymen differ considerably as to when the chick shall have its first food. Good results have been secured when chicks have been permitted to pick a little sand or fine grit from a clean board when about thirty-six hours old, and, when about forty-eight hours old, to eat bread crumbs moistened in milk and squeezed dry. After that almost any of the prepared chick foods may be fed about five times a day till the chicks are two or three weeks old, when they will do well on wheat screenings and need not be fed oftener than three times a day. It is advisable to let the chicks have access to green feed at all times. Fine clover hay, cut with an ordinary straw cutter, is excellent, and also makes a good litter to scatter the feed in. It is best, however, to give the last food at night on a clean board, letting the chicks eat all they will and then removing the board. At other times care should be taken that they be kept hungry, or at least sufficiently so to be eager to eat when fresh food is offered them.



FIG. 14 —A good brooder lamp costing less than fifty cents.

THE CAMEMBERT TYPE OF SOFT CHEESE IN THE UNITED STATES.

INTRODUCTORY PAPER BY H. W. CONN, CHARLES THOM,
A. W. BOSWORTH, W. A. STOCKING, JR., T. W. ISSAJEFF.

[Published jointly by the Storrs Agricultural Experiment Station and by the Dairy Division of the Bureau of Animal Industry, U. S. Dept. of Agr., Washington, D. C.]

INTRODUCTION.

[BY L. A. CLINTON, DIRECTOR STORRS AGRICULTURAL EXPERIMENT STATION.]

The investigations in soft cheese making were undertaken by the Storrs Agricultural Experiment Station with the hope that there might be developed a new industry especially adapted to New England conditions. The Camembert type of soft cheese seems especially adapted to home manufacture. The process of manufacture has, however, been held as a trade secret, and no source of information has been available for those who may have desired to make this type of cheese. A series of preliminary studies was undertaken and the results gave promise of a successful solution of the problems involved and demonstrated the value of the work.

COÖPERATION WITH THE DAIRY DIVISION OF THE BUREAU OF ANIMAL INDUSTRY U. S. DEPARTMENT OF AGRICULTURE.

The continuation of the investigations, however, involved a larger outlay than the means of the Station would permit. Recognizing the wide value which would result should the experiments prove successful and a new industry be established, a coöperative agreement was entered into between the Storrs Agricultural Experiment Station and the Dairy Division of the Bureau of Animal Industry of the United States Department of Agriculture, Washington, D. C. Under the terms of this agreement a thorough study is to be made of the problems involved in the manufacture of some of the types of soft cheese which are so popular in Europe, but which have been manufactured in this country only to a very limited extent.

The Storrs Agricultural Experiment Station has furnished the necessary laboratories, apparatus, and curing rooms for conducting the experiments, and has had the general planning of the work. The Dairy Division of the Bureau of Animal Industry has furnished three experts to assist in the work, viz.: a mycologist, a chemist, and a practical cheese maker, and has provided for certain traveling expenses connected with the work. The organization of the actual working staff connected with these investigations is as follows:

H. W. Conn, bacteriologist of the Storrs Station, supervisor.

Charles Thom, cheese expert of the United States Department of Agriculture, mycologist.

A. W. Bosworth, cheese expert of the United States Department of Agriculture, chemist.

Theodore Issajeff, cheese expert of the United States Department of Agriculture, cheese maker.

W. A. Stocking, Jr., assistant bacteriologist of the Storrs Station.

In addition to the above who have been actively engaged in the cheese investigations, credit is due to Dr. B. B. Turner, chemist of the Storrs Station and of the Connecticut Agricultural College for valuable suggestions, and to Mr. W. M. Esten, laboratory assistant to Dr. Conn for bacteriological determinations. The Connecticut Agricultural College has freely permitted the use of laboratories and apparatus for this work, without which we would have been seriously handicapped.

The work is now thoroughly organized and the investigations are being conducted with the following objects in view:

1. To learn the details of the methods of manufacturing some of the soft cheeses.
2. To learn more accurately the details of the process of ripening and to determine the organic agents involved and their exact functions.
3. To study the chemical composition of the ripened product, the changes involved in ripening, and its relation to food values and digestibility.
4. To discover the difficulties connected with the manufacture of soft cheese and the ways of meeting them.

5. To learn whether the manufacture of a first-class product is possible in the United States.

6. To make public property of all useful and desirable information upon the subject of the manufacture of soft cheese.

This bulletin is necessarily preliminary in its nature, but it will be followed shortly by others dealing specifically with the problems involved in soft cheese making and how to solve them.

CONCLUSIONS.

The conclusions we have drawn at present are as follows:

1. The ripening of Camembert cheese is due to the presence of definite molds and bacteria, not a matter only of manipulation and locality.

2. One mold (*Penicillium candidum*?) produces the principal changes in the curd which gives the texture of the normally ripe cheese; another, *Oidium lactis*, acting in conjunction with the first produces the flavor.

3. The presence of lactic bacteria (commonly used in the form of a starter) produces the necessary acidity of the curd and prevents further bacterial action within the body of the cheese.

4. No other organisms seem absolutely necessary to produce the texture and flavor of the Camembert cheese, though other species of bacteria are always present in or on the cheese.

5. It is possible so to control the process of ripening as to produce such results with reasonable uniformity.

6. It is perfectly practicable to produce first-class Camembert cheese in America.

SOFT CHEESES COMPARED WITH HARD CHEESES.

Hard cheeses have for a long time been well known in this country and have been manufactured by our dairymen in large quantities. Until recently little has been heard concerning another type of cheese properly called soft cheese. This last type, although made from curdled milk, requires very different methods of manufacture, and when ready for the table is a totally different product. As the name indicates, the cheese is

softer, frequently so soft as to be readily spread upon bread like butter. But in addition to this there are other striking differences between the soft and hard cheeses. The soft cheeses are smaller than most of the hard cheeses. They do not keep well. Above all, their flavor is quite different and is usually much stronger. It is a well recognized fact that while cheese is a valuable food because of the large amount of protein it contains, nevertheless it owes its chief popularity to its flavor. Flavors are known to be physiologically necessary to the proper digestion and assimilation of foods. Hence the value of highly flavored foods which give relish to those coarser and less flavored, can hardly be overestimated. The soft cheeses, with their strong flavors, so thoroughly enjoyed by some people, have, therefore, a value decidedly their own.

The primary difference between the hard and soft cheeses is due to different methods of manipulation of the curdled milk. In the hard cheeses (Cheddar, Swiss, American, Edam, etc.) the milk is curdled rather rapidly and the curdled mass subsequently cut into small pieces to allow much of the whey to separate from the curd. Sometimes the curdled mass is heated still further to separate curd and whey. After this the curd is placed in frames and subjected to a high pressure that forces out more of the whey, leaving a very hard mass of tolerably dry curd. Such a curd ripens slowly and is not ready for market for some months, and even when perfectly ripe it preserves its form and never becomes very soft.

The soft cheeses (Camembert, Brie, Isigny, Limburger, Backstein, Neufchatel, Cream cheeses), although each is made in a special manner, all agree in one point. The whey is never fully drained from them. The curdled milk is commonly ladled into forms and allowed to drain naturally. They are not subjected to pressure or heat and they therefore contain a larger per cent. of water at the start than the hard cheeses. As a consequence of their high water content and soft texture various micro-organisms find in them favorable conditions for growth and enzyme action also occurs more readily than in hard cheeses. The action of these two groups of fermentation agents ripens the cheeses rapidly and develops high flavors. The cheeses are ready for the table in a few weeks instead of months, and when ripened have not only strong flavors but

frequently very penetrating and more or less offensive odors, as in the well known Limburger cheese. Because of the rapidity of the chemical changes going on in them these cheeses are more perishable than the true hard cheeses. Their marketable period is very short. If placed upon the table at just the right period they are very appetizing. If insufficiently ripened they do not have the proper flavor or texture, and if even slightly over ripened they rapidly show a tendency to decay and are soon ruined. To place them on the market in such a way as to reach the consumer's table at the proper stage of ripening is one of the difficult problems of the industry.

THE MARKET FOR SOFT CHEESES IN THE UNITED STATES.

The home of these cheeses is continental Europe. No part of Europe is without its types of soft cheese. There are several general types, like Limburger, Camembert, and Brie, that are widely distributed and made in different countries, and there are in addition many local varieties with a narrower reputation. From their centres of manufacture they are exported to various cheese consuming countries, so that all of the chief types are found generally in the various parts of Europe. Importations of soft cheeses to the United States have not been very large. The American market in the past has been almost monopolized by the hard cheeses, principally of the type of the English Cheddar. Americans have known little of the great variety of soft cheeses common in European markets and there has consequently been very little call for them. Within the last generation a moderate demand for soft cheeses has been developed. This demand may be attributed partly to our increasing foreign population and to the desire of people of European birth for the types of cheese familiar to them at home. It is also partly due to the taste acquired by Americans who have traveled abroad, as well as to a growing appetite for them among others who have tried the new delicacies. This has led to the importation of several varieties of soft cheese to satisfy a market which is increasing every year. This importation has reached about a million pounds with a value of about \$150,000 per year.

There are many reasons why the total importations have not been greater. It is difficult to import the more delicate

varieties in prime condition. Two weeks is the shortest period possible between leaving the factory and reaching the retail market in America. If fully and properly ripened before shipment these two weeks cover almost the entire marketable period of the cheese. To reach our market in condition for use at all, they must be packed and shipped before they are in condition for the table. In practice some are shipped before they are half ripe or even when the ripening has just begun. The change of conditions and entire lack of care in transit makes the resulting cheeses which reach our markets of very uncertain quality. It is also difficult for the casual buyer to determine when the cheese is really ripe. These irregularities furnish good reasons why such importation is discouraging to dealer and to consumer alike.

On the other hand, these conditions have stimulated the production of certain soft cheeses in America. Particularly is this true of Limburger cheese for which there is a large demand. It has been found not difficult to manufacture, and it is now made in this country in a number of places with a considerable degree of success. In response to a similar demand a considerable business has arisen in the manufacture of the forms sold in our market as Brie, Isigny, Wiener, lunch, miniature, etc., all of which though sold under all sorts of trade names, have a common type of ripening. Although the details of form and making vary with the factory, the brand, and the season, these may be grouped together perhaps as the "American Brie" type. This American Brie type must not be confused with the French Brie type, for the latter is quite a different product. These American types have made for themselves a large market and may be regarded as a fairly well established product. A preliminary study of their ripening process and the factories in which they are produced indicates, however, a very unsatisfactory condition. The ripening is so little understood and results are so uncertain that one maker admitted that after the cheese is made the flavor of the product is practically an accident over which he has no control. Some of the cheeses are ruined in the ripening and the factories that make them lose considerable of their product. It is evident, therefore, that the manufacture of the American type of these cheeses can hardly be regarded as a success until some means of controlling the ripening can be

devised that shall reduce the failures and give a more uniform product. Moreover, the American type of cheeses is quite different from the French cheeses. It is stronger, has a more unpleasant odor and a less delicate taste. The delicate tasting Brie and Camembert cheeses are mostly imported from France. Up to the present time, their manufacture has been successful in but few places in America, and there is a general belief that their manufacture in this country is impossible.

Another indication of the growing popularity of soft cheeses is the large demand for the varieties sold under various brands as Neufchatel and cream cheese. The basis for most of these is the common "Cottage" or "Dutch" cheese, and many of them are merely sweet or sour curd put in an attractive and appetizing form. The manufacture of these varieties is comparatively simple with practically no danger of loss. They are sold and eaten when fresh. Further, they will yield a larger amount of salable cheese from the same quantity of milk than any other varieties and bring prices almost as high as the best imported cheese. Very naturally these cheeses form the basis of a profitable industry. But here, too, we find that the common American product is different from the cheese in Europe going under the same name. The Neufchatel cheese of Europe is usually a ripened cheese, but the cheese going by this name in the United States is usually unripened curd with an attractive wrapping. Some of these American products, however, are highly flavored and compete favorably with certain ripened types that are imported. All of them command a far higher price than the ordinary hard cheese.

It is certain, therefore, that there is an established and rapidly growing market for the best types of soft cheese. The profit in the manufacture of the hard types of cheese is exceedingly small both to the factory and to the producer of milk, but the prices of the highest class of ripened cheeses (40 cents or more per pound) are so much higher than the prices of the hard cheeses that the introduction of their manufacture should be a great benefit to the dairymen. The fact that soft cheese will not keep very long gives an especial advantage to the domestic over the foreign producers if the products can be made of equal merit. For such perishable products there is a great advantage in an intimate relation between the maker and the consumer.

Factories near enough to a large city to supply the demand with cheese always ripened to exactly the prime condition, should easily be able to control their home market if they can once control their product. It seems possible that there will be an advantage, nearer the small cities at least, in their production by individual dairymen who could dispose of their own product in a restricted market.

The great difficulty in the way of the successful development of the soft cheese industry is in the difficulty of controlling the ripening so as to produce a uniform product. Even in the localities where these cheeses are made in Europe their treatment seems to be purely by "rule of thumb" methods handed down as a result of more or less successful experience, rather than to involve an actual knowledge of the reasons for the various steps in the process. As a natural consequence the results are to a large degree irregular and utterly unexplained failures of every kind are at least very familiar. Recognizing the difficulties in their manufacture in Europe it is not strange that the troubles increase when attempts are made to transplant such industries into a new country, where the practicable rules applicable in the old locality are vitiated by new sets of conditions, in atmosphere, temperature, flavors of milk, and other factors. So great have been these troubles that there is a belief that the American product cannot be made equal to the imported. It is said that the difference in food which the cows eat produces a differently flavored milk, thus making domestic cheeses flavored unlike those imported. Whether this be true or not it is certain that little success has been reached by American makers in trying to reproduce the higher, more delicate grades of European soft cheese. When they have succeeded it has been by importing their help from Europe, and in these cases the makers have carefully preserved their methods as trade secrets. Even in the successful factories many failures occur. Little attempt has been made apparently, and no successful attempt to overcome the new difficulties arising in the new conditions. As a result the home product has commanded an inferior price and is less esteemed than the imported cheese. For this reason the American makers have disguised their goods by French labels, and have not tried to make a market for an American product. The market varieties show great irregularities. Com-

plaint is constantly made by the dealer, and consumer as well, that common brands of some of the soft cheeses are utterly unreliable. In the purchase of a cheese, except by an expert, it is little more than a lottery whether it will be mostly a sour curd or might be eaten through a straw. It is clear then that although there is a good market for uniform and reliable goods, radical changes must be made in the methods of production before these soft cheeses will obtain the large place in the American market which their real merit deserves. For the American dairyman the development of this almost new industry well deserves consideration. It is true that more difficulties are involved in the manufacture of the soft than of the hard cheeses, but the returns are correspondingly greater and quicker. Experience, however, in other lines of dairy work shows that thorough scientific study of the conditions, the problems, and the results sought, is rewarded by the development of successful practical methods of controlling the entire process. The soft cheese will be shown to be no exception to this rule.

CAMEMBERT CHEESE.

Camembert cheese was selected as the first type of soft cheese to be studied, for several reasons. It is one of the most delicate and expensive of the soft cheeses, selling on the market usually for 40 cents a pound. It has been successfully produced by but one large factory in our eastern states. A few other factories have made cheese called "Camembert," but their product has not made for itself a place in our market in competition with the imported varieties. The marketable period of this cheese is so short that the domestic brand should have a great advantage over the imported. The shortness of the ripening period—4 to 5 weeks—together with its high price, insures a good return upon the investment and commends its manufacture to the dairyman located too far from the city to sell his milk as milk. Camembert cheese is already sufficiently well known in this country to insure the ready sale of any brand which shows itself to be always reasonably reliable. Considering the lack of uniform quality in the Camembert cheeses seen on sale in half a dozen of the large cities of the United States, the wonder is not at the smallness of the

demand, but that the people will continue to buy it at all. Inquiry shows that many people are fond of the cheese but never buy it because they cannot depend upon the product. Dealers do not like to handle it for the same reason. The fact that local demand compels grocers in cities, often against their will, to handle such cheeses is evidence that a really good and reliable Camembert cheese would make for itself a large market. It is readily seen, therefore, that the making of this cheese offers good possibilities of return to a large number of dairies or factories each to supply a limited territory rather than an enormous return to a few large concerns. That it requires special study to overcome the difficulties of its production before it can be made by the general dairyman is also evident. For these reasons Camembert cheese seemed to offer a most useful problem.

When we started the work it was impossible to secure at once a cheese maker who was familiar with the factory manipulation in the manufacture of these cheeses. We were therefore, obliged to work from vague and inadequate descriptions of the details of making published in European journals. Practically no detailed description of the practice of the best factories was to be found, while the few scientific papers available scarcely touched the practical problems. Our problem was to imitate a market type without any personal knowledge of how it was produced. The most extended scientific work that had been published was that of Epstein (*Archiv f. Hyg.* Bd. 43, pp. 1-20, Bd. 45, pp. 354-376) who made a somewhat careful study of the bacteria and molds found in a series of ripe Camembert cheeses and endeavored to determine which were the agents of ripening. The conclusion reached was that the ripening of Camembert cheese is produced by the agency of bacteria alone, although he also concluded that the ripening of Brie cheese, which is almost identical with Camembert, is aided by a mold.

In opposition to this, there have been published the results of the work of Roger (*Sep. pub. Soc. Fran. d'Encore. l'Ind. Lactiere*, 1902, and *Revue Hebdomadaire* 11, pp. 327-343) who has also studied the organisms concerned in the manufacture of Camembert. He has reached the conclusion that ripening is produced by the combined agency of a mold and at

least two different species of bacteria. Roger's work has the merit of having been practically applied to the manufacture of Camembert cheese with results which he claims have been very satisfactory. But, on the other hand, Roger has given the public no evidence of the work he has done to reach his conclusions. He has preferred to develop the practical side of his studies as a trade secret, and has therefore in his published articles withheld all details of his experiments and descriptions of his molds and bacteria. Consequently the published account of his work is less useful than that of Epstein. Neither worker has given sufficient data to demonstrate his claims or practical methods of beginning experiments upon cheese making.

The fact that the conclusions of Epstein so totally disagree with those of Roger suggested that the subject at all events demanded further and more thorough investigation. Moreover, it will be seen in the following pages that our own results in a large measure differ from those of both of these investigators, for we have been able to produce Camembert cheese, typical both in flavor and in texture, by a method involving organisms essentially different from those claimed by Epstein or Roger as the cause of ripening. It is scarcely possible that the details of either set of experiments can be all mistakes. The fact that three series of studies upon the same subject have reached three quite different results indicates one of two things. Either the cheeses used in the three different series of experiments have been really different types, though under the same name, or a very similar final product may be produced by different agents. Possibly both of these explanations are needed to account for the discrepancies. Certain of our experiments have yielded information which yields to the belief that each of the three lines of experiment has brought out part of the truth. These results will be discussed in detail later. There is good evidence also that more than one type of cheese reaches the market under the name of Camembert. All of them have sufficient similarities in texture and appearance to lead to classing them together, but in flavor and odor they show marked differences. Camembert cheeses secured from different regions show much variation. The study of the brands offered for sale in several cities emphasizes an entire

lack of uniformity among them. The stage of ripening makes a marked difference in their appearance. One can find upon the same counter cheeses in which ripening has barely become distinguishable mixed with those in every stage of fitness and unfitness for use, even to those which are absolutely putrid, and all are likely to be sold as in prime condition for the table. Such cheeses on the surface may be whitish or grayish in color, or yellowish to reddish and may be dry or sticky with the accumulation of bacterial growths. They may be practically odorless or at least inoffensive to smell, or they may emit very objectionable odors. These differences are not due wholly to the degree of ripeness, for cheeses with very different appearance are often found of the same texture and flavor within. Moreover, cheeses with almost identical surface appearance often differ decidedly in texture and flavor. The external differences we have learned are due chiefly to the different kinds of micro-organisms that grow on the outside of the cheese, some of which are quite unnecessary to the production of the desired ripening. Consultation with dealers shows that there is no accepted ideal among them for Camembert cheese, but they disagree constantly on such matters. There also appears to be confusion in many quarters between the types known as Camembert, Brie, and Isigny. This is probably due to the fact that the imported Brie is ripened in very nearly the same way as Camembert, differing only in size and shape and details of making, while the type we have discussed as American Brie, which includes the cheeses sold as Isigny, is very different in its appearance and ripening process, as well as texture and flavor. It has been shown that certain makers use these names as practicably interchangeable, *i. e.*, regard them as the same general type of cheese moulded at different sizes, and marketable at different degrees of ripeness, and sometimes the same cheese exactly is sent to market bearing different labels.

The true Camembert type of cheese is that imported from France. These are shaped so that they fit wooden boxes about four and one-half inches in diameter and one and one-half inches thick. Upon the removal of their wrappings, the cheeses usually have a rather firm rind about one eighth of an inch thick composed of interlaced fungous threads supporting dried cheese. Within, the ripe cheese should be a yellowish cream color of a

waxy or creamy texture often almost liquid in age, and with a distinct characteristic flavor that is often not present in American types even though they are labeled Camembert.

The first problems which we undertook to study were scientific rather than purely practical. The reasons for this were two. First, we were unable at the beginning of our work to secure a cheese maker familiar with the factory methods of making and curing this type of cheese. Second, it was not our purpose merely to imitate the methods in use in producing this cheese in France. This would have been hardly worth while unless we could obtain a thorough understanding of all the principles involved. It was desirable therefore at the outset, to conduct a series of experiments which would bear directly upon the determination of these principles, and this could be best done by making a few cheeses under controlled conditions. In this way we reached conclusions upon the problems involved which stood the test of practical experiment and which led quickly to successful results when cheese making was actually begun. After securing the services of Mr. Issajeff we began the application of our scientific studies to the practical question of cheese ripening. No description of the practical method of making and caring for these cheeses will be given in this introductory paper. These will be given in a later bulletin to follow shortly. It will be understood, however, that the manufacture of Camembert cheeses is being now actually carried on at the Storrs Experiment Station, and that the scientific results given here have been actually applied to the process of manufacture.

RIPENING OF CAMEMBERT CHEESE.

A brief outline of the ripening of Camembert cheese is as follows: The rennet curd is first ladled into forms, filling them up to a depth of about five inches, and is allowed to stand for several hours for draining. During this time the curd settles until it reaches a thickness of about two inches, when the cheeses are turned and allowed to stand in the forms. During the next twenty-four hours the curd settles still further, reaching a thickness of one and one-half inches. The first change affecting the ripening is the souring of the curd which begins while the cheese is in the forms. In the course of two days the curd has become hard and sour. They are then removed

to the ripening cellar. After a few days in the cellar the molds begin to grow upon their surface. From this time until the end of the ripening period there is little visible external change in the cheese, except in the luxuriant growth of molds and in the fact that during the later stages of the ripening there commonly appears upon the surface of the cheese a brownish red growth which is likely to be moist and slimy. This brownish red growth has been regarded as a necessary factor in the ripening of cheese, but whether it has any necessary connection with it we are as yet uncertain. During the ripening the cheeses at first become somewhat hard and resistant when pressed with the

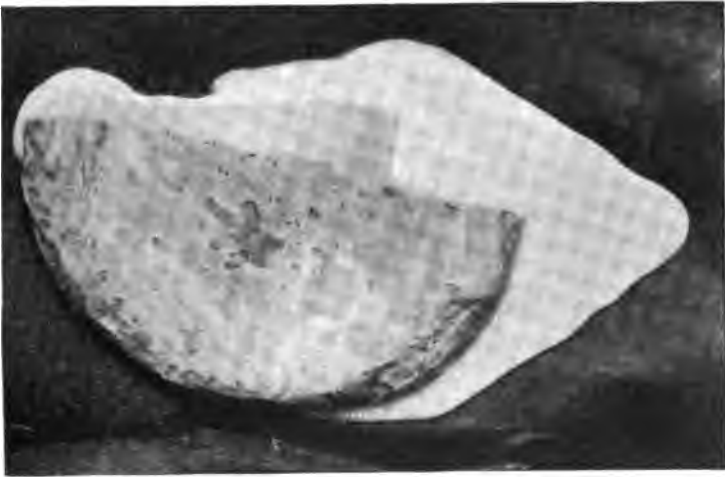


FIG. 14.—An improperly ripened Camembert cheese; the outer portion is liquefied, while the center is hard, sour curd.

finger. Later they soften noticeably and when they approach ripeness they are quite soft and yield readily to the pressure of the finger. The ripeness is determined chiefly by the softness to the touch and is easily told by experience.

The ripening changes are studied by cutting sections of the cheese at various stages. The photographs show such stages of ripening, of which a brief epitome is as follows:

After about two weeks the acidity of the curd begins to be noticeably less, especially at the surface, and as the ripening progresses the acidity in time disappears as far as indicated by

the test with litmus paper. Meantime a change in texture of the curd is evident to the eye. Beginning at the outside there appears a change of the hard curd into a somewhat softer, waxy material. This layer of waxy cheese, beginning at the surface,



FIG. 15.—A series of Camembert cheeses.

1. Unripened cheese.
2. Half ripened cheese with well developed moldy rind.
3. Cheese two-thirds ripened, but with central mass of hard curd showing gas holes.
4. Cheese nearly ripe, and so soft that the upper edge moved from its own weight during the exposure.

slowly extends toward the center and in the course of four or five weeks should reach the center. In half-ripened cheeses there will be found a layer of softened consistency on the outside, with a central mass of acid curd within, which has not yet been affected by the ripening agents. When the cheese is completely ripened the softening extends to the center and the whole cheese, from the outside to the middle, has assumed a consistency of moderately soft butter. When in prime condition the cheese is soft enough to spread upon bread or crackers, but not soft enough to run. An over ripened cheese, however, becomes still softer until in time the whole interior of the cheese below the rind is converted into a nearly liquid consistency, which will run out of the cheese readily if the rind is broken. On the other hand, an under ripened cheese will show more or less of the sour curd in the center which has not been affected by the softening agents.

The cheeses purchased in the market are very frequently in one of these two conditions, over-ripe or under-ripe. (See Figs. 14 and 15).

During the ripening process there appears a peculiar flavor which is characteristic of this type of cheese. The flavor is sometimes not noticeable until the cheese is nearly ripe, so that a cheese which is two-thirds ripened may lack the flavor in question. The final result is a cheese with a firm, moldy rind, and with the contents uniformly soft to the center, and possessing a characteristic, piquant flavor which is found in this type of cheese only.

The problems have been to determine the causes of the phenomena of ripening, and these are manifestly three:

1. The cause of the original souring of the curd.
2. The cause of the decrease in the acid and the gradual softening of the curd.
3. The development of the flavors.

SUMMARY OF SCIENTIFIC INVESTIGATIONS.

Our work has been developed along three scientific lines. The results of each line of study will be summarized here, and the detailed accounts will follow in separate papers.

MYCOLOGY.

The constant appearance of mold in or upon soft cheeses such as Roquefort, Camembert, and Brie, has been referred to already. The works of Epstein and Roger already discussed give two views of their relation to the production of cheese. Epstein believes the mold entirely unnecessary in the production of Camembert, but notes its presence and important function in the ripening of Brie. Roger, on the contrary, believes the mold to be really essential in the ripening of Camembert. Other investigations published, record the constant appearance of mold upon Brie, but give little or no information with reference to Camembert. Popular descriptions of Camembert cheese factories, however, describe the constant presence of a special mold in the ripening cellars. The references to molds in the literature of the subject and their constant presence upon the cheeses, fixed for us a series of questions. What molds are associated with Camembert cheese as found in the market? Which, if any of these, are essential to its proper ripening? Exactly what changes in the ripening process result from fungous activity? What molds are deleterious and what is their action?

With these questions in mind we first made a cultural study of the flora of the Camembert cheeses found in the American market. In this about twenty molds were soon found, isolated in pure cultures and described. A more careful study of our cultures with a comparative examination of the surfaces of the different kinds of cheese showed that only a few of these molds were really common, while but two of them were always present.

With the organism once in pure cultures we next undertook to determine what relation, if any, each might bear to the ripening process. Since it is practically impossible to make cheeses entirely free from other molds, or bacteria, or both, without changing its chemical nature, some controlled means had to be devised to study the various agents of ripening and the steps of the process. We found it necessary to limit this comparative study to the effects of a small group of molds. These were grown in pure culture under known conditions upon milk, casein, curd, cheeses, and special media in order to determine separately different phases of the physiological action of the molds. For this study we used 1, the one we shall call the

Camembert mold (Culture No. 128); 2, the related species isolated from Roquefort cheese which we may call the Roquefort mold; 3, one species of *Mucor*; 4, *Oidium lactis*, and sometimes other species of the same genus *Penicillium*. In some studies the list has been extended to a dozen species in each experiment, because with the larger numbers, comparison of characters gives a better judgment of the real nature of the processes studied.

The souring of the curd as a consequence of the presence of lactic bacteria has already been described as the first change after the cheese is made; also the fact that in Camembert cheese the lactic acid so produced later largely disappears, so that when fully ripe such a cheese commonly has an alkaline reaction to litmus. This disappearance of acid together with the well-known ability of many molds to reduce acidity, has been regarded as the main, if not the only, function of the mold in ripening cheese. This view has been widely quoted. Comparative cultures of a large number of species shows that a very large proportion of the common molds are able to neutralize, if not decompose, lactic acid, but they do this in different degrees and at very different rates. The Camembert mold increases the acidity of the medium during its first few days of growth, then changes and reduces acidity for the remainder of the period of activity. Some other forms reduce acidity from the first and do it much more rapidly than this one. If this were the only function of the mold in cheese ripening, many other species should be equally valuable, or by working more rapidly, would probably be far more effective. This part of the ripening then might be accomplished by any one of a large number of forms.

We then turned our attention to determining whether any or all of these fungi acting in pure cultures possessed the power to change the hard curd to the semi-liquid or viscous condition of the ripened Camembert cheese. A long series of cultures upon sterilized milk, milk agar, and sterilized curd were prepared. Careful bacterial determinations were made to show that the cultures were pure. From these the following facts appeared: Sterile milk is slowly but almost completely digested by nearly every species of fungus tried. Flakes of curd in milk agar plates disappear as a result of the action of the fungi selected

for this experiment. Masses of curd put in flasks and sterilized in the autoclave until they seemed almost the texture of rubber, became nearly completely soluble in water after four to six weeks' action of either the Camembert or Roquefort mold. Experimental cheeses made from time to time with the addition of large quantities of "lactic starter," to exclude other bacteria, were inoculated with this mold and carefully kept pure in bell-jars. Under favorable conditions such cheeses assumed the *texture* of ripe Camembert cheese in from three to five weeks. Repeated analyses have shown that this is approximately the same kind of digestion as is found in the ordinary Camembert cheese. These pure culture experiments have thus shown that this species of mold possesses the ability to change the texture of curd to the texture of ripe cheese in the period of time recorded by the makers of such cheese as necessary for the ripening of Camembert.

How, then, is such a result accomplished? Johan Olsen in describing the Swedish "Gammelost" declares that "He who eats Gammelost eats truly more mold than cheese." In other words, he believes that in its ripening process the changes are due to the complete penetration of the cheese by fungous threads which act directly to change its character. Gammelost would then be fungus flavored with cheese. But cultural studies and careful microscopic examination of hundreds of sections from a number of different Camembert cheeses show that our problem is very different. In Camembert cheese the mold forms a felted mass of hyphae upon the surface and penetrates perhaps one-sixteenth of an inch into the curd. It never reaches even one-third of the distance to the center of the cheese, while its spores are borne only upon the surface. This, together with a very thin outer layer of curd, constitutes the rind of the cheese.

Further, our experiments referred to above show also that on sterile milk the mold forms colonies floating upon the surface only, while a mass of curd in the bottom of the tube, fully two inches away from the nearest fungous thread, may still continue to be digested. It is clearly impossible to attribute these marked digestive effects at such distances to the direct action of the fungous threads upon the medium. From similarity to other known processes, the presumption arises that these are the result of the secretion of enzymes by the mold.

To test the validity of this hypothesis a set of cultures were grown for a long time on Raulin's fluid, then examined by the chemist. The presence of an enzyme capable of digesting proteid was satisfactorily demonstrated. We have, therefore, shown by pure culture methods that the Camembert mold (*Penicillium candidum*?) is not only capable of changing the acidity of the curd, but is able also to cause such changes of the curd as will account for the texture of the ripe cheese and that this result is due to the secretion of an enzyme.

A cheese ripened by this mold alone is white, soft, creamy, and entirely palatable, but is wanting in color and completely lacks the peculiar flavor for which Camembert cheese is sought in the market. After repeated tests had shown the same result, we began to seek for some other organism capable of producing the desired flavor. The discovery of this flavor in certain experimental cheeses at this time was followed by their immediate microscopic examination which showed the presence of the second of the two fungi originally found on Camembert cheese. This mold, the well-known and universally distributed *Oidium* (or *Oospora*) *lactis* had been discarded from much of our work on account of some failures and objectionable results. We now found that the inoculation of this organism upon cheeses partially ripe and lacking flavor would lead to the production of the flavor distinctly in a very few days. Although from its habits of growth its development upon cheese is nearly always accompanied by rapid multiplication of bacteria, this seemed good circumstantial evidence that *Oidium lactis* has something to do with the flavor of Camembert cheese. Additional evidence is found in the fact that the examination of properly flavored ripe cheese of our own make and from the market has never failed to show the presence of *Oidium lactis*, and it has never been shown to be present upon ripe cheeses without the flavor being present also. The great difficulty surrounding complete proof of the agency of a particular organism in producing flavor lies in the fact that the flavors do not begin to appear until the acidity of the curd is much reduced and the digestion attributed in our work to the *Penicillium* has advanced considerably. Flavors, the chemists tell us, are associated with the "end products of digestion." When ripening has reached such a stage as to permit flavor formation, the growth

of *Oidium* upon the surface of a cheese usually becomes complicated by the development of surface bacteria which becomes possible at about that time on account of the reduction of the acidity. A final conclusion as to whether or not *Oidium lactis* alone produces the flavor will depend upon an exhaustive test of those bacteria so constantly associated with it. The bacteriologists, as will be seen later, have shown that few bacteria except lactic species are found within the cheese and none of them seem able to produce flavor. The production of flavor by bacterial action would then depend entirely upon such bacteria as might grow upon the surface of the cheese. In addition to the evidences already mentioned it is found that a cheese entirely covered by a good growth of the Camembert mold evaporates water rapidly and develops a hard, dry rind, so dry as to obstruct the entrance of bacteria from without. In certain of such cheeses, into which *Oidium* was inoculated at the time of making, the characteristic flavors finally appeared without the association of the reddish slimy surface so commonly seen. Further many cheeses made and ripened entirely without *Oidium lactis* have in their later stages become covered with bacteria which produced the surface appearances so often described, but failed entirely to develop the typical flavor. In the light of the bacteriological proof that the interior of the cheese is practically a pure culture of lactic organisms, the production in some cases of both the flavor and texture of properly ripened Camembert cheese without a rich surface growth of bacteria, is very good circumstantial evidence that *Oidium* has some function in producing the flavor.

A cheese inoculated with Camembert *Penicillium* will not begin to show delicate white threads of mold for about three days. The mold develops rapidly from that time until by the tenth day (sometimes by the seventh or eighth) the cheese is usually covered entirely by a pure white cottony mass of threads forming a layer possibly one-eighth of an inch deep. With the ripening of the spores or conidia the color gradually changes to a greenish gray. This change is completed during the third week usually, and no growth seems to take place afterward. During the later stages of mold growth large drops of water are excreted by the mold and evaporate from the surface. The mold therefore has a rather definite period and course of

development. During that time it seems to be so thoroughly adapted to thrive upon cheese as to exclude almost every other form, but after its cycle of development is complete, it may be followed by other species which, if present before, are held in check by the more vigorous species.

One more phase of the mold problem perhaps belongs in this preliminary paper. Efforts have been made to find whether it is possible to substitute other varieties or species of the same genus of fungi for the one we have been using. For such studies the mold of Roquefort cheese has been carried as a check upon our work in numerous experiments. One other variety of *Penicillium* differing only in that it never changes color, but remains pure white, has been tested. Cheeses have been made with these three and several other related species. The Roquefort *Penicillium* grows strongly and rapidly upon cheese but its presence always causes a bitter taste which remains pronounced during the period of four or five weeks necessary for the ripening of Camembert. So strong is this effect that the presence of a colony of this mold less than an inch in diameter may often be detected by the taste of the cheese two inches away. The pure white *Penicillium* in its ordinary reactions to culture media seems to be identical with the Camembert mold, but when tested upon over one hundred cheeses, produced a texture so entirely different from the other as to make the product entirely worthless. It seems most surprising that two forms, so closely related in structure and in every reaction studied, should produce such different results in cheese ripening. Several other forms have been tried. Some produce pigments which discolor the cheese. Some produce bad flavors. A set of four species although allowed to grow for a period of six weeks, produced no softening of the curd. In two of these cheeses especially it was found that the curd was still sour and little changed less than one-fourth of an inch below the colonies of the fungus. The four cheeses used in this experiment belonged to a set of twenty, sixteen of which ripened readily in the ordinary way. Sets of cheeses made from the same milk and treated alike ripened quite uniformly as a rule. Of this set, sixteen ripened in the usual manner when acted upon by Camembert *Penicillium*. Four inoculated with other *Penicillia* refused to soften. Such a result shows that neither the molds used nor the bacteria and

enzymes otherwise present were capable of producing the texture of Camembert cheese in four cheeses of a series, the remainder of which were readily ripened normally.

BACTERIOLOGY.

The universal presence of bacteria in all dairy products suggests, of course, that they may play an important part in the ripening of our cheese. In the various scientific accounts of Camembert cheese bacteria are always mentioned, and both Epstein and Roger attributed to their action a considerable part of the ripening and flavor production. Our own preliminary studies of the market cheeses always showed the presence of bacteria in great number and in considerable variety. It was manifest that most of these were purely incidental organisms not contributing at all to the ripening. In the study of these bacteria the following questions have been kept in mind. Which kinds of bacteria are always found and which are only occasionally present? Which kinds of bacteria are present in fresh cheese? Which kinds of bacteria grow during the ripening? Do any of these bacteria produce the Camembert flavor? Do the bacteria contribute to the chemical changes that occur during the ripening? Part of these questions we have already answered, but part of them require further study.

We first made a bacteriological study of a considerable number of ripened cheeses, isolating all species of bacteria that could be found. Except that lactic bacteria were always found, this work gave no significant results. We were somewhat surprised to find that the group of bacteria that digest proteids (*i.e.* liquefiers) were commonly entirely absent. We had anticipated finding them in large numbers, inasmuch as the cheese is so evidently a digested product. This absence in large numbers suggested that the digestive agent must be looked for elsewhere than in bacterial action.

Our search for a flavor-producing bacterium has thus far been equally unsuccessful. Epstein states that by inoculating into a casein solution one of the bacteria he isolated from Camembert cheese, he obtained a typical flavor. We have been unable to find such a bacterium. We have carefully studied the action upon milk of the organisms isolated from cheeses in the hope of finding a flavor-producing bacterium, but have thus far

been unable to find one. We have, however, found bacteria that produce flavors that remind us of the American Brie, and of other flavors associated with some samples of cheese, but none that give the typical Camembert flavor. We are at present inclined to think that this flavor must be sought in some other line as has been shown in the previous pages.

The study of the growth of bacteria in the cheese during the ripening is very interesting and significant. We have studied this problem in cheeses made with and without a lactic starter. The cheeses made with a lactic starter are more uniform in ripening. Experience has shown that we can with greater certainty obtain a first-class cheese if we use such a starter. For this reason the study of the bacteria in such cheeses is especially significant. The results are very simple for they are an exact repetition of what occurs in souring milk as has been already shown. (Conn and Esten, Rep. Storrs Sta. 1901-2.) At the outset there is commonly a small variety of bacteria present, which develop for a short time. But in a few hours the lactic bacteria get the upper hand and all other species practically disappear. After about two days the cheeses contain a practically pure culture of lactic bacteria. These increase in numbers until they are about 900,000,000 per cubic centimeter, and remain at about this number during the ripening, somewhat falling off toward the end. In these cheeses there is no growth of liquefying bacteria to which might be attributed such digestive action. There are commonly a few of these at the start but they never multiply so that they become abundant enough to lead to the supposition that they are likely to play any part in the ripening. Moreover, as mentioned above, the ripening of these cheeses proceeds from the surface inward, a fact that indicates that the ripening agents are chiefly or wholly on the surface.

These facts are rendered more significant by the bacteriological study of one set of twenty cheeses that were made without lactic starter. In these cheeses the lactic bacteria never obtained such a complete ascendancy over the other species as where a starter was used. While they became very abundant we found that certain liquefying bacteria multiplied and remained in considerable number to the end of the ripening. The presence of large numbers of such enzyme-producing bacteria during the ripening

suggests they may have contributed to the process. It was especially significant to find that: 1. This cheese ripened in the center before it did on the outer edge, as would be expected if the bacterial enzymes aided in the ripening. 2. The final product was in flavor and texture not very different from the more typically ripened cheeses. This would seem to suggest that while the normal ripening is not due to the bacteria or enzymes in the body of the cheese but to the organisms on the surface, under some circumstances the former may materially contribute to the process, and while producing a somewhat abnormal ripening, will give in the end a similar result.

From the facts thus outlined we have reached the conclusion that the bacteria in the body of the cheese are in normally ripening cheeses concerned only in the souring of the curd as preparatory to the later changes. This leads, naturally, to the study of the organisms present in the outer layers. This rind contains a variety of molds and bacteria. The presence of certain molds in the rind of every Camembert cheese examined suggested from the first that they must be important agents in the ripening process. This has been demonstrated in the preceding section; but this rind also, under most circumstances contains many bacteria. Our study of these bacteria and their actions is not yet complete. We have as yet no good evidence that their action is necessary to the production of a first-class product. That they occasionally modify the final cheese is quite certain, and we are also convinced that they play an important part in the ripening of the type we have called the American Brie. Whether they have any influence on the production of the typical Camembert flavor can only be determined by subsequent experiments.*

It should be finally stated that the surface of the ripening cheeses very frequently becomes covered by an abundant growth of yeast, a phenomenon which the makers call "sweating."

* Since the above was in type we have received from France through the Dairy Division of the Bureau of Animal Industry a set of cheeses selected and forwarded by M. Georges Roger accompanied by a letter giving data as to age and condition of ripeness. Studies from the surface of these cheeses have shown the presence of the same *Penicillium* we are using, of *Oidium lactis*, and of the same species of bacteria which appear on our cheeses and contamination with the same other molds we have met. These bacteria on the older cheeses formed reddish-brown slime almost entirely covering the cheese. Systematic tests of these red slime producing bacteria are being made to ascertain what effect they may really have upon the ripening of the cheese. Cultures made from the interior of the cheese showed practically pure cultures of lactic organisms as in our own cheese. These results suggest that we have the same organisms as M. Roger, though under different names.

At present we have no grounds for believing that this has any influence upon the ripening unless it be to check in a slight degree the drying of the surface of the cheese.

CHEMISTRY.

The chemical composition of a normal Camembert cheese is quite well known and considerable work in this line has been done. This work, however, is not of much help in studying the changes that take place during the ripening process and makes it necessary to go over the same ground that has been covered in the work done on Cheddar cheese.

The great difference in the making and ripening of Cheddar and Camembert cheese soon made it apparent that an entirely different set of factors are at work and that the chemical side of the investigation opened a field which would require considerable time to complete.

We have undertaken to follow the chemical changes which render the insoluble curd of a newly made cheese into soluble forms found in a cheese ready for consumption; to isolate and study the enzyme or enzymes which cause these changes; to investigate the changes which concern the production of the peculiar flavor which is characteristic of Camembert cheese; and to show the relation which each of the constituents of a newly made cheese bears to the ripening process.

Up to the present time all our attention has been given to work upon the nitrogen constituents of the cheese. This was because of an early belief, confirmed later to some extent, that the fat plays a secondary part in the ripening and in the development of the flavor in Camembert cheese.

The market product was first studied to establish a standard. This was secured from the analysis of a number of imported cheeses. Our cheeses compared favorably with these, yet we hope to obtain improvement by a slight modification in our methods of making and in handling the cheeses in the ripening cellar (*i. e.* acidity, humidity, temperature, and washing the cheeses).

The first change is the precipitation of the casein of the milk by rennet. This precipitate or coagulum carries down with it most of the fat and some of the milk sugar. The sugar is changed in a few days by bacteria into lactic acid, rendering the

curd distinctly acid in reaction to litmus. The fat undergoes some slight changes, but the precipitated casein undergoes a very marked modification.

Practically no change takes place in the cheese, except the development of acid during the first twelve days. Then the curd begins to soften and is gradually changed from an insoluble lump into a soft, creamy mass, almost entirely soluble in water. This change starts at the outside and progresses inward towards the center until the whole mass has been acted upon.

This change in the curd is probably due to one or more enzymes produced by the molds growing on the cheese. These enzymes begin their activity at about the fruiting time of the molds (about the twelfth day). They have not been separated as yet, but the evidence at hand seems to indicate the presence of both tryptic and peptic-like enzymes.

Some idea of the changes that take place can be obtained from the following table:

TABLE 10.

LABORATORY NO.	Age. Days.	Total Nitrogen. Per Cent. Cheese.	Nitrogen as mono- lactate. Per Cent. Cheese.	Nitrogen as water, soluble. Per Cent. Cheese.	Nitrogen as amide. Per Cent. Cheese.	Nitrogen as ammonia. Per Cent. Cheese.
25 a, - - - -	1	2.73	0.40	0.32	0.23	0.00
25 b, - - - -	3	2.73	0.41	0.41	0.21	0.00
26 a, - - - -	5	2.81	0.39	0.45	0.21	0.00
25 c, - - - -	6	2.73	0.41	0.54	0.27	0.00
26 b, - - - -	7	2.81	0.39	0.52	0.27	0.00
27 a, - - - -	8	2.92	0.43	0.53	0.26	0.00
26 c, - - - -	10	2.81	0.67	0.73	0.38	0.00
27 b, - - - -	11	2.92	0.62	0.75	0.61	0.00
28 a, - - - -	12	2.90	0.63	0.69	0.53	0.00
27 c, - - - -	14	2.92	0.57	1.65	0.48	0.00
28 b, - - - -	18	2.90	0.27	1.76	0.48	0.01
29 a, - - - -	19	2.65	0.34	1.59	0.43	0.02
28 c, - - - -	20	2.90	0.17	1.85	0.42	0.06
29 b,* - - - -	21	2.65	0.13	1.79	0.48	0.06
14, - - - -	28	2.61	†	2.09	0.46	0.21

* This series of cheeses went bad with bacteria after this sample was taken. For comparison the analysis of another cheese, No 14, is given.

† Not determined.

GENERAL CONCLUSIONS.

Although the results of these three lines of work are still incomplete, some conclusions have thus been reached which bear directly upon the practical problems. These conclusions have been put to the test of constant use since the establishment of our ripening cellar, and have brought a much better understanding of the problems involved than was before available.

It has been conclusively shown that the making of Camembert cheese is not dependent upon unique conditions obtainable only in very restricted localities, but rather upon securing the proper cultures and conditions which are possible almost anywhere. Cheeses made at this station have been compared with the best imported goods obtainable in America and pronounced practically identical, not only by members of the force, but by importers and connoisseurs who have eaten this type abroad. These cheeses are in no way inferior in texture or flavor to the best market article. They have been ripened by inoculation with pure cultures and have been watched constantly and tested by the bacteriologists, the chemist, and the mycologist at every stage of their ripening. The element of chance is thus excluded from the result. The organic agents involved are known. The difficulties encountered in the attempts to establish this brand of cheese making in the past have, therefore, been due to insufficient knowledge of the molds and bacteria involved in the process, rather than to failure in obtaining any peculiar conditions or the proper milk.

Our practical work also proves that it will be possible to control the ripening to such an extent as to produce a more uniform product. It has been the practice of the makers in the past to provide suitable conditions and then, as one has put it, let "nature do the ripening." As a consequence of this "hit or miss" way of doing things, some cheeses are inoculated with the proper cultures from the first, some bear one organism and not the other necessary, while wrong species of bacteria and mold very commonly grow in or upon the cheeses, so that the final results are very uncertain. This accounts in a large measure for the variation in appearance, texture and flavor of such cheeses, and is apparently responsible for the differences between the imported and the American made types. It became evident very early that uniformity depends upon the controlling

of the growth of bacteria and molds from the time the cheese is made until the close of the ripening. This pointed to inoculation as the best means of reaching the desired result. Experience has justified this conclusion at every step. The use of lactic starters in butter making had already established a simple means of controlling the development of bacteria. The control of the molds was a more difficult problem, inasmuch as there are at least two different molds, and to obtain a desired result depends upon keeping the proper balance between these two organisms growing upon the same surface, but having different functions. We have learned that by varying the conditions and growth of the *Penicillium* we can, to a large extent, control the development of the other mold. *Oidium* will not grow profusely upon a cheese already covered with the white mold, and by developing a luxuriant growth of the latter we can hold the former largely in check. Cheeses in which the *Oidium* has not developed abundantly are mild in flavor or lacking entirely in the typical Camembert flavor. We have succeeded in producing cheeses perfectly ripened so far as texture is concerned, but flavorless; others with the flavor distinctly developed but mild, and others again with a strongly developed Camembert flavor. Our experiments thus far seem to show that by controlling the growth of these two molds we can control both ripening and flavor production, although as above suggested we have not yet absolutely excluded the possibility that bacteria may play some part in the process of flavor production.

The important practical problem then appears to be to devise methods of treatment that will enable the cheese maker to control the growth of micro-organisms, and primarily the lactic bacteria and two species of molds. The control of the first process of souring of the curd is very easy. It is only necessary to apply here the method now so widely used in cream ripening, the inoculation of the milk with lactic starters. These starters, if placed in fresh milk, ensure a proper souring with perfect uniformity.

The control of mold growth is a more difficult matter, because of the great likelihood that the cheeses in handling will become inoculated on the surface with other than the desired organisms. The solution of the problem, however, appears to be found in proper attention to three factors.

1. The inoculation of the cheese at the proper stage with a comparatively large quantity of the spores of the desired organisms. At just what stage the inoculation should be made and in what way we are not at present prepared to say. The question of direct inoculation of cheese with two molds as a means of controlling ripening is an entirely new one in the discussion of this cheese problem. The practice of the factories has been to allow the cheese to develop the proper mold after entering the ripening room. But there seems to be a good reason for a change in this particular. Milk as it reaches the factory already contains the germinating spores of many species of fungi. Some of these forms develop even more rapidly than the ones essential to our purpose. The proper mold has never been found by us in thousands of cultures of milk as it comes from the barn, while undesirable species are very common. If the *Penicillium* essential to cheese ripening is to take and maintain the ascendancy in the ripening process, it is imperative that it should begin to grow as soon as the cheese is made. Although further experience is necessary to determine the best time and manner of the introduction of the molds, we are convinced that their early introduction gives advantages more than compensating for the additional labor involved.

2. The cleanliness of the ripening cellar. The cheeses remain in the ripening cellar from four to five weeks, where the conditions are kept ideal for mold growth. If the walls, shelves or floors are allowed to become covered with a growth of miscellaneous molds, their spores are sure to reach the cheeses and are then liable to produce trouble. The remedy for this is cleanliness in the ripening room. Special care should be taken to prevent the growth of undesirable molds.

3. The treatment of the cheese in the cellar. We have learned that variations in moisture and temperature of the ripening cellar, and different methods of handling the cheeses all greatly influence the growth of the molds and bacteria. A perfectly uniform method of handling is therefore necessary for perfect uniformity in results. Differences in little matters of

detail are found in the treatment of cheeses in different factories, and these become the basis of each maker's brand. Some wash their cheeses, others do not. Some turn them more often than others. Some send them to the market in a greener condition than others.

In this introductory paper only the general principles can be outlined, and we hope to follow this paper shortly with another giving in detail the actual methods of making and handling, which we have found most successful in producing the best product.

FUNGI IN CHEESE RIPENING.*

BY CHARLES THOM.

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CAMEMBERT AND ROQUEFORT.

It has been shown in a previous bulletin that certain fungi are the active agents indispensable to the ripening of Camembert cheese. The general results and the data upon which they rest are there discussed. The more special mycological studies involving several lines of work remain to be brought out in greater detail. These fall naturally under two heads: (1) The physiological studies of the functions of particular species in the ripening processes of Camembert, Roquefort, and certain related types of cheese. (2) The classification and description of these and other forms occurring in dairy work. This paper will include the work that has been done under the first head only. The description of the dairy fungi occurring will be reserved for another paper.

* The experiments in cheese making are conducted in coöperation with the Dairy Division of the Bureau of Animal Industry, United States Department of Agriculture.

L. A. CLINTON.

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CAMEMBERT. RESUMÉ OF PREVIOUS PAPERS.

The biological conditions and the physical changes encountered in the production of a Camembert cheese from market milk may be restated from our former bulletin as a basis for defining the special problems of the mycologist.

Milk as ordinarily received contains bacteria of many species and the germinating spores of numerous fungi from the stable and from the food of the cattle. When such milk is curdled for cheese making, representatives of all of these species are enclosed in the mass or coagulum. Freshly made cheese from this curd, then, may contain any species of mold or bacterium found in the locality, which is capable of living in milk or its products. The first step in the ripening of a Camembert cheese is the production of lactic acid. The lactic bacteria* very soon increase their rate of multiplication so enormously as to become entirely dominant. The acid produced by these forms soon reaches a per cent. sufficiently high to restrict the further growth of nearly every other species of bacteria, and even to eliminate the organisms themselves when present. In a time varying from a few hours to three or four days, according to the proportional numbers of these antagonistic species at the start, further bacterial growth seems to be entirely stopped. Bacterial development can not begin again until this acidity is reduced below the critical point for the species involved and even then, since the acid is neutralized on the outside first, for most species, it begins at the surface and works slowly inward. The uncertainties due to the presence of many species of bacteria in the milk are in this way avoided by the natural, simple and practically universally successful process of souring.

* Storrs Agricultural Experiment Station Bulletin No. 35, p. 25.

The further ripening of a Camembert cheese is attended by a gradual reduction of this acidity until the ripe cheese is usually alkaline to litmus. At the same time the mold action produces chemical changes in the mass of curd, which in from three to five weeks reduce the previously insoluble mass to a high percentage of solubility in water. In the latter stages of this ripening, compounds are formed which give the characteristic odors and flavors to this type of cheese. Associated with these chemical changes there is a progressive physical change from the firm curd to a soft buttery or even semi-liquid texture, characteristic of ripe cheese. The biological problems then were, in general, the determination of what organisms cause:

1. The changes in the acidity of the curd.
2. The changes in the casein with the associated changes in the physical character of the cheese.
3. The production of the flavors.
4. The recognition and control of deleterious species.

CULTURE MEDIA AND METHODS.

The common dairy fungi grow readily upon any of the standard culture media. Among the media used have been peptone agar, whey gelatine, sugar gelatine with or without the addition of litmus, milk agar, gelatine and agar made with Raulin's fluid, potato agar, potato plugs, and sterilized milk and curd. Special studies have involved other preparations. The fact that these fungi grow readily upon all of the common media has led to the selection of two preparations for constant use, and the careful study of all species found upon these. For this purpose the sugar gelatine described by Conn* for the qualitative bacteriological analysis of milk, and potato agar have been used.

The sugar-gelatine formula produces a type of carefully made and accurately titrated medium in which every effort is made to secure a uniform composition. Although absolute uniformity in chemical and physical properties is never obtained, the reactions of many species of fungi, when grown upon successive lots of gelatine made after this formula, have been so reliable as to commend its use for determining physiological characters.

* Bacteria in Milk and its Products, p. 268.

It seems clearly shown, therefore, that slight variations in composition of the medium do not produce great differences in the species studied in this paper. In the discussion of the relation of a mold to this gelatine it must be borne in mind that the same results might not follow the use of any other formula.

Potato agar was selected because of its use in many mycological laboratories. In the preparation of this medium, uniform composition can hardly be claimed. The following process has been used in this work. The potatoes are carefully washed, pared and sliced, then slowly heated for about two hours in approximately two volumes of water. At the close of the heating the water is allowed to boil. The whole is then filtered through cloth, and commonly also through cotton; water is added to make up the losses of evaporation and filtering. To this is added one per cent. of shredded agar. It is then heated in the autoclave to 120° C. or higher, for from twenty to thirty minutes, when it may at once be put into tubes for use, or if cloudy it may be very quickly filtered through absorbent cotton, after which it should be quite clear. The uncertainties in the composition of this medium result from the differences in the potato extract itself and from the fact that the difficulties in filtering this extract take out a varying amount which is replaced with water. Titration shows that this medium is nearly neutral (4-6 acid on Fuller's scale) in cases tested to phenolphthalein, consequently it is used without neutralizing. Culture and study of the same species upon successive lots of this medium show that these differences in composition have little if any effect upon the morphology of the species studied.

Petri dish cultures have been used continually because they admit of direct study under the microscope. Slanted test-tubes were found useful for stock cultures and for gross studies of physiological effects, but are of little value for comparative work. It is useless to attempt to get a correct idea of the normal gross structure of these molds from fluid mounts. The extremely delicate hyphae are so tangled in such preparation as to give but very little idea of their ordinary appearance, while the chains of conidia break up immediately when placed in any fluid. Such mounts are useful and necessary to get at details of cell structure and cell relations, but in comparative

studies of species of such a genus as *Penicillium* their value is only that of a useful accessory. The primary source of comparative data must be direct study of the growing colony undisturbed upon the culture medium, with the best lenses that admit of such use.

This method of study recognizes that morphology is the basis of fungus determination, but takes into consideration :

1. That morphology must not only include the minutest details of cell structure and cell relations such as are undisturbed in fluid mounts, but also the appearance and character of the colony.

2. That the morphology of the colony—*i. e.* the size of conidiophore and fructification, relation of these to substratum, appearances and relations of aerial and submerged mycelium—is different upon various substrata, but has been found to be characteristic for each particular substratum.

3. That a description of morphology to be of value must therefore, specify the formula of the medium used and the conditions.

Dilution cultures have been necessary usually to obtain the colonies pure, but the direct transfer of large numbers of spores upon a platinum needle to the surface of gelatine or agar plates which have been allowed to cool have been found to give equally reliable results and to have many advantages for the study of species once obtained in pure culture. This is often spoken of as inoculation of cold poured plates. Litmus solution may be used with either gelatine or agar and gives striking evidence of differences in, and in the rate of the physiological action of different species. Bacterial contamination has been usually restrained by the addition of from two to four drops of normal lactic acid to eight or ten cubic centimeters.

EFFECT OF A FUNGUS UPON A CULTURE MEDIUM.

In studying the relation of a fungus to a culture medium we find (1) that the fungus absorbs food from the surrounding medium; (2) that it may secrete or excrete substances into the medium which may transform its chemical composition and its appearance. The amount of food absorbed by the fungus

is small, and for our purposes may be practically ignored; but the changes induced by indirect action—secretions from the mycelium—are great and far reaching. To this latter group belong the changes in acidity, digestive effects and flavors produced by fungi.

LITERATURE OF CHEESE FUNGI.

A review of the literature at the outset showed that no work on the fungous flora of the various types of soft cheese had been published in English. Epstein at Prague studied the ripening of Camembert and Brie cheeses. He attributes the changes in the curd in French Brie to the action of *Penicillium album* (?), but denies the participation of molds in the ripening of Camembert. Johan Olsen in Sweden has published a brief review of the fungi related to the ripening of Gammelost, barely mentioning work done upon Camembert. Marpmann in Leipzig has listed many fungi as found in studies of cheese. Constantin and Ray in France have described the appearance upon the cheese of the species of *Penicillium* involved in the ripening of the French Brie. Roger, also in France, has attributed a single phase of Camembert cheese ripening to the activity of *Penicillium candidum*,* for which he gives no description. Of these references, that of Epstein and that of Constantin and Ray describe the mold found upon the French Brie sufficiently clearly to aid in its recognition. A popular article in the Creamery Journal of October, 1904, gives in entirely untechnical language a very satisfactory description of the appearance upon cheese of the *Penicillium* concerned in the ripening of Camembert. The general insufficiency of the literature available made a first hand study of the types of cheese found in the American market the only source of material and definite information.

BIOLOGICAL ANALYSIS OF A CHEESE.

In the biological analysis of a market cheese it is carefully unwrapped to avoid contamination as far as possible. Series of dilution cultures on neutral and acid media are made at once from each part of its surface which shows any variation in appearance. In this way all the surface molds and bacteria

* The use of the specific name *P. candidum* is probably incorrect.

are secured in one set of plates. Afterward this surface is examined in detail, usually with a lens, the appearance of the different areas is noted and direct transfers from each area are made to cold agar or gelatine plates. The cheese is then cut with a sterile scalpel and cultures are made from various portions of the interior. Usually the transfers were made from the center and from the area just inside the rind. Any part showing special appearances is reserved for a separate series of cultures.

Most of the brands of Camembert cheese found in our market, also some sent by Roger, have been examined in this way. For comparison similar studies have been made from several specimens of Roquefort cheese bought in different markets, and from individual specimens of Gorgonzola and Stilton. Single studies for molds have been made from Limburger, Port du Salut, Brinse, and from several brands of prepared cheese found in the market. From these cultures all species of bacteria found have been isolated and handed over to the bacteriologists. Every variety of mold occurring upon these cheeses has been isolated and studied. It has been possible in this way to show that a comparatively small number of species characteristically occur upon soft cheese. Although this list may be greatly extended by including forms which are occasionally found, it is rather surprising to find a restricted group of species occurring with much regularity in studies of cheese from so widely different countries.

To study the origin and distribution of these molds several laboratories and cheese factories have been visited and cultures taken. Correspondents in distant states have kindly sent cultures of molds occurring in their work. Among those who have sent material are Dr. C. E. Marshall, Agricultural College, Mich.; Mr. E. G. Hastings, Madison, Wis.; Professor F. C. Harrison, Guelph, Ont.; Dr. H. A. Harding, Geneva, N. Y.; Professor P. H. Rolfs, Miami, Fla. Thus, in addition to a large number of cultures from the dairy laboratories of the Station at Storrs and at Middletown, we have accumulated a considerable number of species representing the characteristic molds occurring in dairy work from several sources, as well as many forms collected in the field, and from laboratories not associated with dairy investigation.

THE FLORA OF CAMEMBERT CHEESE.

Although a considerable variety of molds appeared in cultures from Camembert cheeses, a list of possibly twenty species would include those which were often found. Among these there are perhaps six species of *Penicillium*, two or three of *Aspergillus*, *Oidium lactis*, *Cladosporium herbarum*, one or two of *Mucor*, one or more of *Fusarium*, *Monilia candida* and two species perhaps related to it, with the incidental occurrence of *Acrostalagmus cinnabarinus*, a *Cephalosporium*, various species of *Alternaria* and *Stysanus*. Besides these, yeasts in large numbers and considerable variety are found in many cases.

THE CAMEMBERT PENICILLIUM AND THE OIDIUM LACTIS.

The comparison of the results of culture with comparative studies of the surfaces of different brands of cheese showed that one species of *Penicillium* was present upon every Camembert cheese examined. In partially ripened cheeses this mold often covered the larger part of the surface. We shall call this the Camembert *Penicillium* or the Camembert mold. This species develops a large and characteristic growth of aerial mycelium in addition to a densely felted mass of threads which penetrate the outer one or two millimeters of the surface of the cheese, and which largely constitute the rind. In all except a few very old cheeses, which were almost covered with red slime of bacterial origin, it was readily seen to be the dominant species upon the surface. Similarly, cultural data showed *Oidium* (*Oospora*) *lactis* to be abundant upon every brand of Camembert. This mold is practically indistinguishable upon the surface by its characters except under very favorable conditions, and at best its recognition, even with a hand lens, is not often certain. Mycelium of this fungus develops only in very moist substrata and is usually entirely submerged. Only part of its chains of conidia even rise above the surface. In old and very ripe cheese when the rind is covered with yeasts and bacteria it is often difficult, under the microscope, to find the spores of *Oidium*. In such cases, unless one is familiar with the peculiar smell associated with its action, he must depend entirely upon the culture for evidence of its presence.

No other species of mold has been found upon every cheese examined, although no market cheese has failed to show contamination with at least one or two of the other fungi listed above. In other words, comparative biological examination of imported Camembert cheeses established the fact that these two species of mold were present upon them all, however abundantly they might be contaminated with other forms. The examination of hundreds of cheeses in the city markets has shown the presence of the same two molds upon all the brands of Camembert offered for sale. Such analysis clearly established the presence of these molds upon the ripe cheese, but gave no information either as to whether they were necessary or what function, if any, they might have.

Experiments were therefore devised to test the relationship of these molds to the ripening processes outlined above. The constant occurrence of other molds also upon the cheese brings up the question, How and to what extent do they affect the ripening process? The experiments have been made to include as many species as possible therefore. Where detailed chemical analyses were necessary the work has necessarily been restricted to a few forms.

For this purpose in addition to the Camembert *Penicillium* and *Oidium lactis*, the *Penicillium* found in Roquefort cheese (der Edelpilz of German authors) has been usually used. For convenience it is called the Roquefort *Penicillium* or Roquefort mold. One of the *Mucors* probably *Mucor* (or *Chlamydomucor*) *racemosus*, is so commonly found that it has been often included. A pure white mold closely related to the Camembert *Penicillium* has given some interesting contrasts. When reference is made to any of the numerous undetermined green species of *Penicillium*, they will be indicated by the letter or number under which they appear in the record book of cultures, and under which the origin and subsequent cultural history of all species studied has been kept.

These studies involve two classes of data, (1) those experiments requiring quantitative analyses which have been conducted in coöperation with Mr. A. W. Bosworth, chemist to this investigation. The results of such series of analyses will appear in his report; (2) experiments which show the physiological characters of the fungi by physical changes in the

appearance, texture or color of the medium used, or by the production of flavors. The results may be anticipated here by noting that these two classes of data did not prove mutually interdependent, but that chemical analysis may show in general the chemical conditions found in a ripe cheese without the necessary texture and flavor and conversely the practically necessary texture and flavor may be obtained in a cheese differing considerably in its chemical condition from the standard market article. In our practical experiments we sought first for proper appearance, texture and flavor of the cheeses, then without disturbing these, endeavored so to control chemical changes of the casein as to satisfy the standard of chemical composition established from the study of market cheeses.

I. RELATION OF MOLDS TO ACIDITY.

The development of lactic acid has been shown to be of primary importance in the control of deleterious bacteria. In our previous paper it has also been seen that after doing its work this acidity gradually disappears in the ripening process. The disappearance of the acid has been attributed by Roger (Rev. Hebd. 7 pp. 334) and by Epstein (Archiv. f. Hyg. XLV. pp. 373) and by Mazé to the activity of molds and interpreted as preparing the way for the action of peptonizing bacteria. This view of the relation of molds to cheese ripening has been widely quoted as their only function in the process.

The acid exerts practically no selective action upon any of the molds studied. Stoll has recently shown that species of *Penicillium* grow readily in media containing much higher percentage of acid than ever occurs in cheese work. The use of acid in fungous cultures to restrain bacteria is practically universal. But the action of the different species of mold upon the acid is very different. This is strikingly shown by the introduction of a solution of litmus into the culture media used. Litmus gelatine or litmus agar may be a deep blue if used at 15 acid on Fuller's scale as is usual for bacterial studies, or a clear bright red if two to four drops of normal lactic or other acid are added to 10 cubic centimeters of medium. No mold cultivated in this work has failed to show some definite relation to acidity indicated by litmus reaction. Some fungi as soon as they develop visible colonies begin to change red (acid)

media to blue (alkaline) and maintain this character consistently. Many others when grown in blue gelatine (designating by *blue*, gelatine 15 points acid to phenolphthalein—10 points alkaline to litmus on Fuller's scale) begin by changing the blue to red. This change may vary from the faintest tinge of red in only that part of the medium directly in contact with the threads of the young colony to deep red over large areas. *Oidium lactis* and Roquefort *Penicillium* produce at times a very slight pink, which barely traces the outer limits of the young colonies before the blue reaction begins to appear. At other times the red if appearing at all has been so evanescent as to be overlooked. It has been suggested that this slight appearance of acidity might be due to the excretion of carbon dioxide in respiration, which although continuous, is afterward masked by many times larger changes in other substances.

The Camembert *Penicillium*, and several of the very common green species of *Penicillium*, when grown upon blue gelatine, at first turn all the substratum in contact with the growing colonies to a bright red. Some species produce areas of red beyond the limits of the mycelium. These effects are most clearly seen by examining the colony from the under side. Later a spot of blue appears in the center of the colony below and gradually extends outward, until commonly the entire mass of culture medium has become blue. This often involves a change of reaction in agar or gelatine two to three centimetres beyond the colony. It is thus clear that there must be either the secretion or the excretion by the mycelium into the medium of a substance capable of changing this reaction, or the absorption from the medium of some substance, thus changing its reaction. The exact nature of this change has not been determined. Increase in the percentage of acidity or of alkalinity retards the change of reaction. In certain experiments phenolphthalein was introduced into red litmus media and several species of *Penicillium* and *Oidium lactis* were grown upon it. With the Camembert *Penicillium* the entire mass of agar became blue in a few days, remained so for nearly three weeks, then the characteristic pink color for the alkaline reaction of phenolphthalein appeared on the under side of the colony. This was tested by opening the colony with a platinum needle and introducing a very small drop of normal acid, when the pink

area was changed first to blue and then to red. As the acid diffused outward from the center the wave of blue travelled outward, being replaced constantly by red until all trace of the phenolphthalein reaction was gone. The other species used did not give this reaction. There are forms including some species of *Penicillium*, *Aspergillus niger*, *Monilia fructigena*, and others, which produce the acid reaction in litmus media without any change to blue. Several species of *Penicillium* rapidly produce the purplish color which is characteristic of the turning point of litmus at which their further development occurs, apparently these bring acid or alkaline media to that point without further change. It would appear then that the relations of these molds to acidity as indicated by the litmus reaction is reasonably uniform. To determine whether the litmus reaction would be reliable upon a medium closely allied to cheese, test tubes of separated milk were prepared, blue litmus added, and the tubes sterilized. Eleven species of *Penicillium* were inoculated into these tubes and observations were made every day. Of these, four species including the Camembert *Penicillium* produced a layer of red milk for a few millimeters below the colonies which later was changed back to blue. The other species either intensified the blue or produced no change.

The suggestion has been made that neutralization of acid is due to the production of ammonia. A series of cultures were made in coöperation with Mr. A. W. Bosworth to test the production of ammonia compounds by mold action. The species used were the Roquefort *Penicillium*, the Camembert *Penicillium*, *Penicillium* sp (Record No. 310), *Oidium lactis*, *Oidium* sp (Record B), and *Aspergillus niger*. These were grown upon potato agar to which litmus and lactic acid were added. The *Aspergillus* culture remained bright red, all the others became deep blue. Upon analysis the *Aspergillus niger* was found to have produced the largest amount of ammonia. Study of the figures showed that the ammonia alone was not sufficient to neutralize the acid used in any case. It is clear then that the lactic acid must have been neutralized by some other basic products of digestion rather than neutralized by ammonia. If the acid were absorbed and dissociated after absorption the area of blue would be restricted to the neighborhood of the hyphae or the diffusion of the acid for considerable distances would

produce purple tones instead of sharply marked areas of red and blue. The data seem to indicate that chemical decomposition or neutralization of acid must be the action of some product excreted by the fungus, probably an enzyme.

It has thus been shown by many experiments that the Camembert *Penicillium* and *Oidium lactis* are two of many species capable of reducing the acidity of the media upon which they grow. Many other species of the same genus produce this effect more quickly than the Camembert *Penicillium*. Some act at about the same rate as this one. The reduction of the acidity of the cheese may clearly be attributed to these molds, but the study of the relations of many other molds to acids indicates that any of a large number of species might be equally or more useful for the accomplishment of this step in cheese ripening. If, therefore, these particular molds are essential to Camembert cheese ripening their special function must be sought in other steps of the process.

2. THE DIGESTION OF CASEIN.

The changes in firm sour curd which result in the production of the soft buttery or semi-liquid texture of the Camembert cheese present some very complex problems. These may be grouped as (1) the purely chemical questions which involve qualitative and quantitative analyses of the material at every stage; (2) the biological and physical questions which deal with the agents and conditions which produce these results and with the gross appearances of the final products whose descriptions do not depend upon detailed chemical analysis.

1. The chemist (Bul. 35, p. 29) describes the general course of these processes and the nature and extent of changes as a digestion in which the insoluble or but slightly soluble compounds of casein found in sour curd are rendered almost completely soluble in water. The details of the process and the data will appear in the report of the chemist later.

2. To determine what relations the molds might have to the chemical changes involved a great many cultures on different media. In some experiments the number of species used was large and the results acquired in that way a comparative value, but in the more complicated trials the work was limited to those mentioned above.

It is practically impossible to produce a normal cheese in such a way as to avoid contamination with bacteria or molds. It is difficult, therefore, to study the relations of organisms to the steps of cheese ripening directly upon cheese. Even were this possible the complexity of the changes encountered would make the interpretation of the phenomena difficult. The activities of these molds have, therefore, been studied in pure culture upon a series of media which would give information as to steps of the process. While these cultural studies were being made many cheeses were made and inoculated with the Camembert and Roquefort *Penicillia*. The measure of success obtained from cheese inoculated with the Camembert *Penicillium* gave good practical ground for its continued study. These detail studies may be best discussed separately.

LIQUEFACTION OF GELATINE.

The liquefaction of gelatine media has been much used as an index of digestive activity. All species obtained have been grown upon neutral and acid sugar-gelatine and the effects noted carefully.

The difference in action between the molds important in this investigation are striking. The *Mucor* produces a slow but rather complete liquefaction; *Oidium lactis* will gradually soften the gelatine so that the center of the colony is liquefied; a pigment producing *Penicillium* (recorded simply as "O") will liquefy all the gelatine in contact with it so quickly that it comes to be a floating colony in a watery pool twice its own diameter in a week. Several other species of *Penicillium* have the same effect. The Roquefort *Penicillium* softens gelatine somewhat, but never produces a watery liquefaction. The Camembert *Penicillium* often produces a slight liquefaction under the center of the colony, but never extends that liquid area to half the total size of the colony. This seems to indicate that the *Penicillium* "O" and its allies would produce a rapid digestion, that the *Mucor* would be somewhat slower, that the Camembert mold might have some digestive effect, and the Roquefort mold very little, if any, value. The test of the ability to liquefy the gelatine used gives therefore only indefinite or negative results as to any advantageous relation of these particular species to cheese ripening.

Comparative study of numerous cultures of many species of fungi upon gelatine gives, however, some very interesting suggestions. In many species which liquefy litmus gelatine rapidly, the area of liquefaction is surrounded by a blue (Alkaline) band. For example, in one experiment with *Penicillium* "392," at its most active period of growth a colony fifteen millimeters in diameter was surrounded by a liquefied area four to eight millimeters wide. This area was in turn surrounded by a band of intense blue shading gradually in a width of perhaps ten millimeters into unchanged red litmus-gelatine. The medium which had been liquefied was almost colorless. Several suggestions may be drawn from many such observations. The change in acidity of the medium as has been noted above may be affected at a distance of two to three centimeters from the colony. This change of litmus reaction advances faster than the area of liquefaction of the gelatine. The breadth of the area of liquefaction shows that the action of the fungus is not a digestion by contact, but the secretion into the medium, of diffusible digestive agents, *i. e.*, enzymes. In most of these species liquefaction occurs only in areas having alkaline reaction. No general relation between acidity and digestion is established. The substantial uniformity of the results of repeated cultures of the same species of fungi upon gelatine made after the formula used, established its usefulness as a test of the ability of an organism to perform this particular digestion. It will be shown later that the ability to liquefy this variety of gelatine is not to be regarded as a general test of the ability of a species to produce active proteolytic enzymes.

RAULIN'S FLUID.

To test the ability of these species to grow in a medium entirely lacking in proteid, Raulin's fluid was used as given by Smith and Swingle (B. P. I. Bulletin 55) but modified by leaving out the potassium silicate and zinc sulphate. Sterilized flasks of this solution were inoculated with *Mucor*, *Oidium lactis*, Camembert *Penicillium* and Roquefort *Penicillium*. All four grew. The *Oidium lactis* and *Mucor* did not appear to develop entirely normally. Both species of *Penicillium* grew richly and fruited normally. The culture of the Camembert mold, after growing several weeks, was examined chemically

and a proteolytic enzyme was demonstrated to be present, in digestive experiments conducted by Mr. Bosworth. In this way it was shown that this fungus could not only construct proteid from inorganic compounds of nitrogen but would produce proteolytic enzymes in such a solution. Enzyme studies were not made for the other species used in this experiment.

CASEIN.

For a medium at the opposite extreme, the chemists prepared pure casein. This was weighed into two gram lots moistened, sterilized in the autoclave and inoculated with five species of mold. All grew and fruited luxuriantly. This experiment showed only that the species used were able to break down casein and to grow normally upon the products of this digestion without the addition of other nutrients.

STERILE MILK AND CURD.

Sterilized milk and sterilized curd offer a substratum related to cheese. Sterilized milk in quantities varying from forty cubic centimeters to one hundred and fifty cubic centimeters in test-tubes and Erlenmeyer flasks has often been used. Nearly all species of *Penicillium* grow luxuriantly forming a felted mass of mycelium often two to four millimeters in thickness upon the surface of the milk. With the absorption of the milk in such cultures of the Camembert and Roquefort species the mass of mycelium buckles and bends, tubercles of mycelium arise on the under side of the mass and grow downward keeping the mold in connection with the fluid. In this way a culture may continue to grow for several months until it forms tough, irregular masses of felted hyphae, filling the test-tube for an inch or more downward from the original surface of the milk. The milk below the colony soon becomes transparent giving reactions for digestion, with a residue of curd at the bottom, which in the course of time may be almost completely dissolved. With the *Oidium lactis* on the contrary the colonies largely sink below the surface so that the milk may be quite well filled with mycelium upon which chains of spores are only produced in quantity at or just below the surface. Similar experiments with 100 grams of sterilized curd in flasks, inoculated with the Camembert and Roquefort molds have shown

that either species is able to change the chemical composition until the derivatives of casein are almost completely water soluble. Such cultures were plated to show their freedom from contamination by bacteria before analysis. The resulting products give the standard reactions for digestion. These experiments show that either of these molds is capable of producing digestive changes comparable in their completeness, rapidity and general nature to those shown by analysis to have occurred in the ripening of Camembert cheeses.

DOES THE MYCELIUM PENETRATE THE CHEESE?

It must be noted carefully that this action of the Camembert mold goes on without the complete penetration of the substratum by the mycelium of the mold. That this is true is readily seen in milk cultures where the limits of the development of the mycelium are sharp and clear. The same fact has been demonstrated for cheese by hundreds of sections and careful cultural studies many times repeated. The mycelium forms a dense mat upon the surface of the fluid or the mass of curd, or the newly made cheese. It follows the irregularities of the surface and is not found to enter well-packed curd to any extent. It is very difficult to prove that hyphae of this mold actually appear in curd of uniform texture below one or two millimeters. When found deeper in, careful search usually shows a cracking of the surface so that the mycelium may follow the opening already made. In no case of many hundreds of cheeses studied and experiments performed has the mold been found to fruit in cavities not opening broadly upon the surface. This is in marked contrast to the habit of the *Penicillium* instrumental in the ripening of Roquefort cheese, which penetrates the channels of the substratum and fruits in every cavity large enough to accommodate a conidiophore. The Roquefort mold will make every cavity in a cracker or piece of bread green with spores, while the Camembert mold will fruit upon the surface of the bread or cracker with only vegetative mycelium inside the bread.

Definite experiments to prove that this digestive power on the part of the *Penicillium* is due to the secretion of one or more enzymes, have given characteristic reactions for digestion many times. Without discussing these chemical reactions

here, it has been shown that the action of the fungus is carried on at distances from the mycelium which preclude direct action. The enzyme, must therefore be secreted and diffuse outward from the mycelium into the substratum. This explains why the Camembert cheese begins to ripen just under the surface and why this action progresses inward from all sides until the cheese is entirely ripe. Before this process is complete the center is simply sour curd. A good illustration of this action is seen in cheeses which are ripened without turning. In such cases the development of mold and enzyme on the lower surface is prevented and as a consequence ripening is delayed on that surface.

CAMEMBERT *PENICILLIUM* UPON CHEESE.

Many cheeses have been made and inoculated with this mold alone in conjunction with pure cultures of lactic starter. Little difficulty is found in this, since if an abundance of spores are put upon the cheese when made, this mold seems capable of taking and maintaining the lead of all others. A cheese made in this way and ripened for from three to four weeks will finally be rendered creamy, or under some conditions, waxy throughout; in color, white within; in flavor, almost neutral; having no particular character good or bad, and hence to a lover of Camembert cheese, tasteless and insipid. The important features of this ripening process are then, the completeness of its action and the entire absence of any objectionable character in its flavor. Biological analysis has shown that the center of such a ripened cheese may be practically a pure culture of lactic organisms. The texture is, therefore, obtainable by the use of the *Penicillium* alone.

COMPARATIVE STUDIES OF FUNGOUS DIGESTION.

Comparative tests of digestive action have been made for a number of molds. The Roquefort *Penicillium* has been used in parallel cultures with the Camembert *Penicillium* in many determinations. It has shown equal or greater ability to digest milk and curd. A typical example of several series consisted of cultivation of eleven species of *Penicillium* upon sterilized milk in large test tubes. Observation of results after seven

days showed digestion by seven of these species. Five of them appeared to digest milk at least twice as rapidly as that species, in the first week.

In another series, milk agar was made by dissolving one to two per cent. of the agar in water at 130° C. and pouring together equal quantities of the hot agar and hot sterilized milk. If poured into petri dishes at once this medium was smooth and clear, but if acidified or sterilized after mixing, flakes of precipitate appeared. The flaky precipitate in the acidified cultures was found very useful as an indication of digestion. In cultures upon the surface of such plates where digestive action was strong, the flakes would entirely disappear. Twenty-three species of mold were tested upon milk agar in this way. Of these, eight produced a distinctly stronger digestion than the Camembert *Penicillium*; five produced digestion approximately equalling that species, and ten produced less digestion. These cultures were mostly made in duplicate and both results in all but two cases agreed fully. *Oidium lactis* produced comparatively little effect upon this medium.

TABLE II.—*Reactions of Certain Species.*

	Litmus.	Liquid Gelatin.	Digestion of Curd.	Digestion of Milk.	Growth at 5 to 10 degrees C.
Camembert,	{ red, then blue	partial	medium	medium	slow fruiting
Roquefort, -	blue	softening	rapid	rapid	characteristic
Oidium, - -	blue	incomplete	slow	slow	characteristic
Mucor 12, -	blue	incomplete	slow	—	poor
Mucor 19I, -	blue	incomplete	slow	—	—
'O' - - -	blue	rapid	rapid	rapid	—
300, - - -	blue	partial	{ medium to rapid	rapid	retarded
132, - - -	{ red, then slowly blue	slight	medium	—	—
310, - - -	{ red, then blue	slight	{ slow to medium	slight	slow
68, - - -	{ red, then blue	partial	slow	medium	slow fruiting
Monilia candida No. 198,	blue	rapid	rapid	rapid	—
P. brevicaulis,	blue	rapid	rapid	rapid	—
392, - - -	blue	rapid	slight	rather slow	—
240, - - -	blue	rapid	rapid	—	—
Aspergillus niger, -	red	rapid	—	slow	—
135, - - -	blue	rapid	—	rapid	—
136, - - -	{ red to purple blue	partial softening	medium	—	characteristic

Two species of *Penicillium*, "68" and "310," found closely associated upon cheese with the Camembert *Penicillium*, produced little digestion. The Roquefort *Penicillium* and several other molds often found upon Camembert cheese appeared to act much more rapidly than the Camembert mold itself.

All of these series of cultures under different conditions, many times have shown the same results and prove that the *ability to digest curd is common to many species of fungi*. The species we have been led to call the Camembert *Penicillium* possesses this character in common with numerous other molds, many of which act more rapidly than this one.

After the ability of several molds to digest curd is established, the relation of any particular mold to cheese ripening must be determined by the character of the products of that digestion and the flavors associated with it. No pure culture upon a medium previously sterilized by heat has given a taste resembling that of Camembert cheese. Cheese made and kept in an atmosphere of chloroform, which prevented mold and bacterial development, refused to ripen. Numerous cheeses made and not inoculated with molds have uniformly failed to develop the texture and flavor of Camembert cheese; although such cheeses have usually become covered with molds of various species. The type of cheese made and sold in this country as Isigny and Brie, and sometimes labeled Camembert, which always shows *Oidium lactis* associated with bacteria, differs entirely in appearance, texture, odor and flavor from Camembert; yet *Oidium lactis* is capable of neutralizing the acid of the cheese much more rapidly than the Camembert *Penicillium*.* The necessity for the presence of another agent in this ripening is clearly established.

More than two thousand cheeses have been made and ripened at this Station with the Camembert mold under varying conditions. Hundreds of these cheeses have shown repeatedly that cheese so made will assume in ripening the texture of the best imported article. The Camembert *Penicillium*, therefore, is seen to be able to neutralize the acid of the freshly made cheese and to produce the texture desired, but not the flavor. It remains to determine whether other molds may not be equally

* Nevertheless the center of such a cheese remains acid for a longer time than is required to ripen a Camembert cheese while the texture of Camembert is not produced.

useful in this process. For comparison, cheeses have been made and inoculated with the Roquefort *Penicillium*, with undetermined species of *Penicillium* appearing on the record as "O," "300," "310," "68," "132." Of these species one, "310," when cultivated upon every medium used except the cheese duplicated the reactions of the Camembert mold completely. Its morphology is scarcely distinguishable. It differs only in that it remains pure white during its entire cycle of development, while the Camembert species turns gray-green in age. The close relationship apparent, together with a promising test, led to its use upon over 100 cheeses. The changes in curd resulting from its action were widely different. These cheeses were drier, waxy, with a mealy, crumbling layer just under the rind. The physical character of the results and the flavor produced were so different that the cheeses were entirely worthless. This mold was originally isolated from a market Camembert cheese where it was found mixed with others.

The presence of the Roquefort *Penicillium* may be seen by the spots of green it produces and may be detected by a sharp, bitter, perhaps astringent taste. The texture of the cheese produced is different and the flavor, when it is present in any large amount, is so strong as to be very objectionable to many. When present in small amounts upon a cheese it gives a certain sharpness or piquancy to it, such as has been often found in certain brands of imported cheese and is sought for by some buyers.

The species marked "O" and "300" secrete a bright yellow pigment into the cheese which colors every area with which it comes into contact. A cheese was inoculated with "300" and examined when eight weeks old. It had produced no trace of the texture of Camembert. The center of the cheese remained practically sour curd, while the portion for perhaps one-fourth of an inch under the colony was decomposed.

The species marked "68" has been obtained from cheese from widely different sources. In cultures upon milk and milk agar it produced little action upon the casein. A cheese inoculated with it remained largely sour curd for two months. The species marked "132" is a very common green form, appearing in dairy and other cultures. It has given no satisfactory results when grown upon cheese. In this way, related species found in cheese work have been tested in their effects upon

cheese and shown not to produce changes comparable in physical character to that demanded in a Camembert cheese, and constantly obtained by the use of the Camembert *Penicillium*. There seems to be no further question but that this species of *Penicillium*, among all the molds so far studied, is the only agent capable of producing the characteristic texture of the best type of Camembert cheese with no objectionable flavors or colors.

FLAVORS.

All attempts to produce the flavor of Camembert cheese in pure cultures of milk and curd with particular organisms have failed. Here again we have had to depend upon the use of cheeses so that direct, positive proofs have not been possible. The value of the indirect or circumstantial evidence offered must depend upon the completeness with which all factors have been considered. It has been previously shown that a cheese may be ripened to the texture of the best Camembert by the action of lactic bacteria and the Camembert *Penicillium* (*P. candidum* or *album*?) but that it will lack flavor. A series of difficulties are met here. The typical flavor does not begin to appear until ripening is well along. This would indicate that the flavor producing agent or agents must act upon already partially ripened cheese to produce the particular *end-products* which give this flavor. But coincident with this the acidity of the curd has become so far reduced that bacterial development may now occur on the surface at least, and as a matter of observation few cheeses begin to show flavor until cultures from their surface show swarms of bacteria of various species. It has not been practically possible to change these conditions sufficiently to make cheeses bearing only pure cultures upon the surface. The problem becomes then one of comparative study, and the elimination of the unnecessary factors one by one rather than the direct production of the flavor sought in a single conclusive experiment.

Some organism or organisms must be sought for to produce the flavor. The appearance of the flavor of the imported article in certain experimental cheeses at this stage of the investigation led to their immediate study. This showed that *Oidium lactis* was abundant upon these cheeses and emphasized

the fact that it had always appeared in cultures from market cheeses. *Oidium* had been excluded from many experiments in cheese making because it had been found to be associated with odors that seemed undesirable, as well as because of the conclusion of Epstein from his researches, that the presence of *Oidium* is uniformly deleterious. The inoculation of a half-ripened cheese lacking flavor entirely, with spores of *Oidium* produced the flavor distinctly in a single week, but since bacterial action seemed always associated with this, further evidence was necessary. Roger and Epstein have attributed the ripening of Camembert to the action of certain bacteria without distinguishing that the production of the texture of the cheese is accomplished by a different agent from the production of flavor. In their descriptions, ripened Camembert is always referred to as slightly reddish in color, and the appearance of this color is regarded as an indication of the progress of ripening. In cheeses selected and forwarded by M. Roger this red color was very prominent and the red layer was found to consist of myriads of bacteria of a few species. Cultures from these cheeses showed that *Oidium lactis* was also present in abundance. Numerous tests have been made with the bacteria found associated with the various brands of Camembert cheese hitherto without producing the flavor in any case independently of the molds. The comparative study of many cheeses from the market and from our own cellars seem to show that cheeses may have the typical Camembert flavor without the development of any specific surface growth of bacteria. The character of the bacterial growth upon the surface appears therefore to be incidental or accidental, though its presence may be necessary as maintained by Mazé in a recent paper, to exclude air.

Cheeses of good flavor have both been produced here and purchased in the market which indicate that particular surface appearances are not essential to the typical flavor. Similarly the introduction into new cheeses of species of bacteria found in cultures from the interior of good cheeses has produced either no effect whatever or disagreeable flavors. Thus far, therefore, no species of bacterium has been found capable of producing the Camembert flavor. Although the flavor question is manifestly still unsettled, we may offer the following summary of the data at hand upon relation of molds to flavor in Camembert cheese:

1. *Oidium lactis* has been found in every brand of Camembert cheese studied.

2. It has never been found upon a ripened Camembert cheese which lacked the flavor.

3. The flavor has never been found in a cheese without the *Oidium*.

4. Every other species with which the flavor seemed obtainable has been eliminated from one or more experiments without loss of flavor.

5. Bacteria or other molds do in many cases modify the flavor of Camembert cheese but do not seem to be able to produce it independently of the mold. There thus arise characteristic secondary flavors which are associated with the output of certain factories and which command special markets. These varieties are usually more highly flavored than what we have regarded as typical.

The essential relation of the Camembert *Penicillium* and *Oidium lactis* to the production of Camembert cheese is, therefore, well established. Several mycological questions remain. What are the optimum conditions of temperature and moisture for the use of these molds in cheese ripening? What are the most practicable means of cultivating material for inoculation? How can the proper inoculation with these molds be most effectually secured? What other fungi occur as contaminating species and how can they be controlled?

TEMPERATURE.

Since the higher temperatures of the ripening cellar lead more rapidly to the development of bacteria it is necessary to determine the lowest temperature which will permit mold growth and also enzyme action. The different species respond quite differently to temperature. In one experiment eight species were inoculated into slanted tubes of gelatine and put in a refrigerator where the temperature varied from 5° to 10° C. Of these the Camembert *Penicillium* and two nearly related species Nos. 68 and 310 grew, but fruited very slowly, showing an inhibiting effect. The Roquefort *Penicillium* grew and fruited normally as also did *Oidium lactis*. The species of *Mucor* used developed very slowly and fruited only slightly.

Two of the very common green species of *Penicillium* grew richly. *Oidium lactis* grows abundantly in the Brie and Isigny cellars visited. In these the temperature was 50° to 55° F. (11° to 12° C.). Numerous experiments in the ripening cellar show that the Camembert *Penicillium* does not grow at its best in a room cooler than 60° F. (15° C.) and that to obtain rapid development the room should be slightly warmer. Until this mold is well established, therefore, it is distinctly an advantage to grow it at a temperature of 65° to 70° F. Repeated experiments have shown that lowering the temperature to 52° to 55° F. checks the rate of ripening very materially. A difference of less than ten degrees between two rooms will often make as much as two weeks difference in the ripening period of cheeses from the same lot in the two rooms. A temperature as low as 54° to 55° F. as given in an article in the *Creamery Journal* referred to above appears to prolong the ripening period without contributing any compensating advantages. A half-ripened cheese was cut, the progress of the softening of the curd was noted, and the cheese put in a refrigerator where it was held for four weeks at 48° F. It was then found to be completely ripened and perhaps a little old in one place, but the changes noted at the end of this period would have been produced within a single week at 60° F. The cold storage possibilities suggested by this experiment will be further studied.

Some experiments were made to show the resistance of spores to heat. The spores of the Camembert and Roquefort *Penicillia* were inoculated into gelatine and placed in an incubator. Heating for an hour and fifteen minutes at 56° C. killed all spores of the Camembert species. Only a few spores of this mold grew after one hour at the same temperature, while some spores of the Roquefort *Penicillium* grew after two and a half hours.

HUMIDITY.

The use of very moist cellars and caves in the ripening of this class of cheeses is practically universal. The richest development of mold is seen in rooms where the atmosphere is saturated or nearly so. This appears to be exceptionally true for species like Camembert *Penicillium* which is purely a milk fungus, and in which there is a large development of thin-walled

aerial mycelium. So dependent is the Camembert mold upon abundance of moisture that it has been found difficult to secure a rich growth upon the surface of a cheese which has been drained for two or three days before inoculation. Contrary to directions commonly given for ripening these cheeses, which call for a particular degree of humidity, cheeses have been ripened successfully in our cellars at the saturation point as well as at the various degrees of humidity below that. A good illustration of a mold which has adapted itself to changes of moisture is found in a mold numbered 198.* Upon a fresh cheese in a moist room, this organism forms a circular ring-like colony of floccose hyphae standing often eight millimeters high upon the surface of the cheese. In a drier situation, or when the cheese is nearly ripe and the rind becomes harder and dried, the same mold produces conidiophores which barely rise above the substratum so that the surface of the cheese is covered by a white powdery layer which is practically pure spores. The mucors are so sensitive to moisture that they scarcely develop upon the cheese, except sometimes during the first few days when the surfaces are very wet. They appear to be unable to withstand the rate of surface evaporation in the ripening cellars.

INOCULATING MATERIAL.

The problem of propagation of the Camembert *Penicillium* for inoculation purposes presents some difficulties. This species bears spores only upon the surface of the culture medium used, in contrast to the Roquefort species which develops spores in every air space when grown upon bread as well as on the surface. To produce spores in quantity, therefore, material must be capable of sterilization and must present the largest possible amount of free surface in proportion to the space occupied. For the preparation of such material quart fruit jars have been used. Various styles of crackers have been tried. Most of these were not successful. The most suitable appears to be the hard, dry "water cracker." The jar is filled with crackers, and dry sterilized at 140° to 160° C. for an hour or more, better twice on successive days. The spores may be added directly

* Comparison with *exsiccatæ* in Harvard University Herbarium identified this with specimens labeled *Monilia candida*. But this is not *M. candida* as understood by Hansen.

or first inoculated into about 100 cubic centimeters of sterile water (acidified with 1.5 per cent. of lactic acid usually) and this poured into the jar and shaken until all the crackers are wet. Various types of "milk cracker" soften to a pasty mass in this moistening process. The best water crackers are not very satisfactory, because the mycelium tends to transform bread or cracker into a soft gummy mass. The crackers become overgrown and matted together until they present much less actual surface than might be expected. The substitutes tried have been excelsior, hay and sheets of cardboard wet with milk or whey. Although some of these have advantages, they were on the whole less satisfactory than the "water crackers."

So far, therefore, no material has been found so easily prepared and so satisfactory as the "Schimmelbrot" of the Roquefort cheese makers, on account of the very different habit of our mold.

From the point of view of the use of pure cultures the *Oidium lactis* is even more troublesome. This mold produces a large proportion and in some strains all of its spores as chains below the surface of the substratum. For pure culture work petri dish cultures have been the only satisfactory means used. Its enormously rapid development, however, makes possible the propagation of a culture from day to day from the draining boards upon which the cheese is made. These become heavily coated with a slimy mass of mycelium and spores upon standing over night. Direct transfers from them have been used with apparently no serious trouble from contamination. In fact so capable is the *Oidium* of self-propagation in dairy work that Epstein declares it to be present in all dairy work. Although Roger in his published statement does not mention it at all, it was found abundant upon the cheese forwarded by him to this Station. We have succeeded by careful work in making many cheeses entirely free from *Oidium* but with the ordinary treatment of dairy utensils it appears constantly in factory practice. It is practically possible to rely to a considerable extent upon the ability of the *Oidium* to propagate itself as has hitherto been done in the factories.

INOCULATION WITH *PENICILLIUM*.

With the *Penicillium* however numerous experiments indicate that there is much advantage in early and effective inoculation from the cultures of known purity. Whether such inoculation must be always made from specially grown laboratory cultures is questionable. In factory practice, making room and ripening cellar are usually adjacent rooms. If precautions are taken always to have on hand some cheeses bearing pure cultures (and the cheese maker must know his mold so well that there will be no question about it) one or two such cheeses will furnish enough inoculation material for much newly made product. This would be indicated by the rough calculation that from the abundance of the chains of fruit and the size of the spores (.005 millimeters in diameter) probably there are about enough spores produced to cover evenly the surface upon which they grow, perhaps 25,000,000 to the square inch. Very successful inoculation in seventy-five pounds of milk has commonly been secured by tapping a petri dish culture over the vat or by breaking a piece of cracker about an inch square or less and stirring it into the milk.

The most economical and successful method of inoculation so far devised has been the use of sprinkling jar or can. For this purpose holes one millimeter or less in diameter in the jar lid are demanded. A small amount of water is put into the jar, a piece of cracker or cheese covered with mold is broken into the water, the top is then screwed on and the jar thoroughly shaken. The water is then sprinkled upon the newly made cheese at the time of first turning, so that both sides of each cheese receive a few drops of water. Excellent results have been obtained in this way with the smallest amount of inoculating material and the least requirement of labor and skill. Such a jar should be emptied and washed immediately after using. The mixture is made fresh each time. Milk may be used instead of water as was first suggested and tried by Dr. Conn, but the water has been found the most easily managed. The practical method for factory use will probably vary with the conditions and skill of the maker.

VITALITY OF SPORES.

Studies have been made upon the vitality of the spores of the species used. This varies greatly in different species. In some of the most common forms spores have been reputed to remain viable for several years. Recent studies by Wehmer showed that five species of *Penicillium* used in his experiment were entirely dead in laboratory cultures at the end of two and one-half years. Cultures of the Camembert *Penicillium* grown upon potato in test tubes plugged with cotton have refused entirely to germinate at the age of one year. Other cultures have seemed entirely dead inside of six months. In fact the spores of this mold are very thin-walled and lose in percentage of viability very rapidly when stored. Under such conditions they lose turgidity and become crenulated or indented. Spores of *Monilia candida* and several others have grown after more than a year in laboratory cultures, but their germination was much retarded. *Oidium lactis* seems to be very easily killed by drying as would be expected from a species with such thin-walled spores. The Roquefort *Penicillium* under some conditions is more resistant but loses vitality quite rapidly. It is certain therefore that material for inoculation should be fresh and vigorous to give the best results. Under ordinary circumstances it would not be desirable to attempt to use material more than a few weeks old.

CONTAMINATIONS.

The number of molds found upon market Camembert cheese shows the need of care in guarding against contamination of cultures. Extraneous molds may come (1) from the milk (2) or from the utensils used, (3) from the clothes and hands of the workmen. Although the milk is the primary source of most infections, practical experiments have shown that if the proper molds are put upon the cheese at the time of making the troubles arising in this way may be minimized. In fact, sufficient contamination from this source directly to ruin a cheese is very uncommon.

The very habit in some countries of washing or rinsing cheese making utensils in whey will account readily for the universal presence of *Oidium lactis* and perhaps for many of the bacterial infections that result in loss. But the source of the most

trouble in a cheese cellar is found to be the cheese maker himself. The cheeses are commonly exposed upon curing boards, turned and examined in the hands. In this way spores from molds or bacteria occurring accidentally as single colonies upon single cheeses are distributed by thousands to hundreds of cheeses. The product of a factory may almost be identified in the markets by the contaminations upon the surface of its cheeses. Certain brands of the cheese always bear *Monilia candida*, and commonly one or two other *Monilias*. A species of *Fusarium* is distinctive of another brand with *Acrostalagmus cinnabarinus* occasionally present. After numerous experiences with all sorts of contamination this trouble has been practically eliminated from our experimental work by putting the fresh cheeses as soon as they are drained, salted and comparatively dry upon the surface, into boxes which are slightly larger than the cheeses, leaving air space and room for mold to develop normally. In this way fingering is done away with, the cheese is turned by turning the box, and examined by removing the lid without touching the surface, so that a colony of mold appearing upon one cheese is no longer distributed through the cellar.

It is, therefore, possible to produce cheeses practically free from molds other than those inoculated upon their surface. Although such boxing is practically undesirable on account of expense upon a large scale, it remains certain that it may be very useful in eliminating troubles which do occur without so large a loss as would come from discarding all infected cheeses, many of which would ripen very satisfactorily but for the danger of spreading obnoxious fungi over great number of cheeses.

ROQUEFORT CHEESE.

The well known Roquefort cheese is another highly flavored cheese in which mold has long been known to play a part. In manufacture, this cheese approaches the hard type, but the ripened cheese bears a closer relation to the soft cheeses. Many very complete descriptions give the details of its making and curing. These need not be repeated here. Roquefort is by description a goats' or sheep's milk cheese, made in France principally, though cheese of nearly the same quality is said to be made in other parts of Europe from mixed cows' and sheep's milk, or from cows' milk alone.

The great popularity of Roquefort cheese makes information as to the biology of its ripening processes very desirable. To this end numerous specimens of Roquefort have been purchased and analyzed. The results of this work have been very much simpler than the studies of Camembert. The ordinary Roquefort cheese, before it is sent to the market, is carefully cleaned and covered with tin foil. Its surface would, therefore, tell very little. When cut it is seen to be traversed by channels or holes made by the Prickelmaschine and by cracks. Every air space is lined with green *Penicillium* so that the cut surface is said to be marbled with green. The texture of the cheese is reasonably uniform with every indication that ripening is simultaneous throughout the cheese or at least approximately so. Its texture is rather crumbling than waxy, with a tendency to dissolve readily in the mouth. The taste is characteristic, a sharp flavor, in which a rather high salt content is noticeable. Its odor is strong, cheesy rather than offensive in any way, except as pronounced putrefactive odors are sometimes developed in the rind. Cultures from the surface often show various species of fungi. There is no regularity about the surface, however, while uniformity of texture and appearance is universal on the inside. Cultures from the interior show a remarkable uniformity. In many cheeses examined a pure culture of a single species of *Penicillium* has been found. The extremely rare appearance of any other mold in the cultures has been remarkable. Similarly the bacterial content is usually limited to typical lactic forms. Sufficient analyses have been made to establish clearly that a first-class Roquefort cheese should contain only lactic bacteria and the Roquefort *Penicillium*. This *Penicillium* is often referred to by writers as *P. glaucum* and regarded as *the common green species*, but as it has very characteristic morphological and physiological characters it seems best to designate it as the Roquefort *Penicillium*, even though it quite often occurs upon other substrata.

The cultures which have been conducted in connection with the study of Camembert cheese have shown that the Roquefort *Penicillium* is capable of digesting curd very completely. Here as in Camembert cheese, chemical analyses have shown that the derivatives of casein become almost completely water soluble.

Further, pure culture experiments upon sterile curd have shown that this mold in the earlier stages of ripening produces bitter flavors during the first few weeks, but that its continued action changes these to typical flavors of the Roquefort cheese. Here we have a definite positive result. It is thus shown that the Roquefort *Penicillium*, acting with the lactic bacteria, is capable of ripening Roquefort cheese, without the introduction of other enzyme producing or flavor producing organisms. The investigations of the chemical nature of these changes have barely been touched upon at this time. In a recent experiment a cheese of the Roquefort type was made of cows' milk, inoculated with the Roquefort *Penicillium*, and kept in a room at a temperature of about 60° F. At the end of five weeks this cheese was found to have acquired both the texture and the flavor of genuine Roquefort. There seems to be no doubt but that it will be possible to develop methods of making and ripening that will produce the Roquefort type of cheese successfully in the United States. Details of making and handling will then be offered.

OTHER CHEESES RELATED TO ROQUEFORT.

Single studies have been made from the Italian Gorgonzola, English Stilton and Hungarian Brinse (Brindze or Brimse). Gorgonzola and Stilton are made from cows' milk. Brinse is described as made from sheep's milk, mixed sometimes with goats' milk. These three varieties of cheese are found marbled with green *Penicillia* in pure cultures, which are unquestionably one or more strains of the Roquefort *Penicillium*. In the Gorgonzola and Stilton cheeses examined, lactic species were the only bacteria found. Comparison of the flavors in these cheeses shows that the differences lie rather in the qualities of the materials used in making, and in the handling of the cheese, than in the qualities attributable to ripening organisms.

It is peculiarly interesting to find the same species of mold in the interior of ripened cheese in four countries so widely separated, where no efforts at the use of pure cultures are known to be made. Experiments show that in every locality so far studied there are many green species of *Penicillium*. It is evident then that the food material or the conditions or both presented by these types of cheese must exert a selective influ-

ence upon the molds, which results in the dominance of the one species so universally found. This species has been introduced into experimental cheeses at this Station.

AMERICAN BRIE AND ISIGNY.

Cheeses of the type referred to in our previous bulletin as the American Brie have been studied for comparison. This was a collective term suggested to cover cheese sold under various labels as Brie, Isigny, Wiener, Miniature and others, designated commonly by the retailer simply as Brie. The name Brie seems to be applied in the French dairy literature to a cheese which differs from the Camembert in the process of making, but ripened by the same fungi and approximately in the same way as Camembert. The domestic product so far as examined is quite different, with the exception of the out-put of one factory which is conducted by imported cheese makers. The cheese met in the eastern markets under these names shows no trace of the Camembert *Penicillium*. Numerous brands have been examined in the market and many hundreds of cheeses have been seen in the cellars of two of the largest cheese companies. *Oidium lactis* is universally present upon these cheeses, but its presence goes practically unnoticed by the makers since it produces neither color nor aerial mycelium. All noticeable molds are washed or scraped from the surface of the cheese. The washing produces exactly the best conditions for the growth of bacteria and *Oidium*. This treatment results in a cheese without a very definite fungous rind, with a strong flavor and smell.

Cultures from this type of cheese indicate that there is an associative action between the *Oidium lactis* and various species of bacteria. Several species of *Penicillium* occur as contaminations in these cellars, and sometimes are found upon the cheeses in the market. Every effort is made to eliminate mold action other than that of *Oidium lactis*, which usually passes unrecognized. Cheeses of this type usually bear rich growths of yeasts, giving a characteristic greasy feeling to the surface. Exactly what parts these various organisms play in the production of Brie is as yet undetermined.

Single studies have shown that *Oidium lactis* is the dominant mold upon the surface of some brands of Limburger, brick and

Port du Salut. There is then good reason to believe that this fungus is associated with nearly every type of highly flavored ripened soft cheese met in the American market.

THE MOLDS REFERRED TO IN THIS PAPER.

The Camembert and Roquefort molds belong to the hyphomycete genus *Penicillium*, which has been characterized by one author, "hyphae broadly effused, creeping; conidiophore branched at the apex in an irregularly verticillate manner, producing brush or broom-like forms; conidia in chains, hyaline or bright colored, spherical or elliptical."

This genus of fungi contains a large number of very poorly described forms which are everywhere abundant as the "green" or "blue" mold of the household, the dairy and the granary. They form patches upon and just under the surface of the materials upon which they grow. The patches are composed of delicate threads of mold which are matted together, forming more or less cottony surfaces, never rising more than a small fraction of an inch above the substratum. At first these areas are always white, but in most species the ripening of a crop of spores is indicated by the change to a color which is usually some shade of green, though this may later give place to a brown. In a few species other colors appear. These spores (conidia) or propagating bodies are minute, thin-walled cells averaging possibly one five-thousandth of an inch in diameter, and so light that they float freely in the air. A breath upon the surface of such a colony carries away thousands of them, when if held in a proper position, they may commonly be seen to rise in a cloud. If the colony be held to the nose and inhaled they give the sensation commonly called the "smell of mold." They are then exceedingly light; they are produced in immense numbers; they are capable of growing in almost every conceivable situation, upon anything which is not definitely and strongly poisonous. Some of these spores are short-lived, others cling tenaciously to their power to germinate. Of the species probably a dozen common ones may be expected in any locality, perhaps more. Our studies have shown that they affect very differently the substances upon which they grow. It is then clearly necessary that we know the forms we are to use by thorough study of their characters and habits,

and just as important that we know how to get rid and stay rid (if it be possible) of those we do not want. The discussion of the whole group will be reserved for another paper. Here we may describe in simple terms the two cheese fungi we find important, but it may as well be acknowledged at the outset that with the possible exception of the Camembert species, safe recognition of species without technical knowledge and cultural study is out of the question.

THE CAMEMBERT MOLD.

The spores of the Camembert mold grow rather slowly in comparison with the other molds of the group. They first swell to nearly double size, then produce fine threads or hyphae at from one to three points on their surface. Upon a cheese or in laboratory culture the subsequent growth of these threads forms a colony large enough to be visible with the naked eye, in ordinary room temperature, in about two days. Usually in four or five days the colony will have become loosely white cottony, about one-half inch or less in diameter, and perhaps standing one-twentieth of an inch above the surrounding surface. At or about this stage the center of this colony begins to turn a shade of greenish grey, which is characteristic of this species, though one or two other forms produce colors closely resembling it except to one very familiar with the shades of color in question. This is due to the presence of ripe spores. Upon the cheese in the cellar this color often does not appear in less than a week or even ten days. Microscopic examination shows that the submerged threads of mycelium of such a colony do not go deeper into the solid media than one-sixteenth of an inch, and that the superficial portion of the mycelium spreads as fast or nearly so as the part beneath the surface of the substratum. This fungus grows and fruits for about two weeks, in some cases this may be prolonged to three weeks, and at the end of that period no further growth is to be expected from the primary colonies. Nor if the medium is undisturbed is there a secondary growth from the germination of the spores produced by the first colony. In case the rind of the cheese is broken so that a fresh surface is presented, the spores will develop new colonies upon such areas. A colony then produces a single crop of spores and dies, under ordinary

circumstances, and in undisturbed cultures there is usually no second growth from the spores or from the old mycelium, although the contrary has been claimed for this fungus by a recent writer (Mazé, 10). A cheese inoculated with this mold will become covered with pure white, cottony mycelium in about a week. The color will then begin to show the grey-green shade characteristic of the species, which spreads until at the end of the second week the entire surface, if left undisturbed, will be colored.

Persistent search has failed to find a single colony in America whose presence can be attributed to anything but Camembert cheese, imported from Europe. The mold may then be regarded as a typical dairy form which is not well adapted to cosmopolitan conditions, and to the struggle for existence on all sorts of media. In fact in the course of laboratory practice involving thousands of cultures, even in the laboratories of this Station, this mold rarely appears as a contamination, although it has been cultivated in quantity and used in the inoculation of large numbers of cheese in the same building with the bacteriological laboratory. Moreover, the spores are easily killed by heat, and retain their vitality for only a few weeks in ordinary cultures allowed to dry in the air at room temperature.

The following technical characterization may be offered, based upon studies made upon the sugar gelatine and potato agar described in this paper, after the plan outlined in my recent paper in the Journal of Mycology.

Penicillium Camemberti (*nomen novum*). *—Colonies effused, white (sometimes yellowish white) slowly changing to grey-green (glaucous); surface of colony floccose, of loosely felted hyphae about 5μ in diameter, reverse of colony yellowish white; conidiophores $300-800\mu$ in length, $3-4\mu$ in diameter, septate, cells thin-walled often collapsing in age, arising as branches of aerial hyphae; fructification sometimes 175μ in length but usually much less, consisting commonly of one main branch and one lateral sparingly branched to produce rather

* In offering a new specific name for this mold the author is aware that the name *P. album Epstein* is accepted for this mold by Mazé and others; also that Lindau has substituted for *P. album Epstein*, *P. Epsteinii* Lindau on examination of the literature alone. The previous use of the name *P. album* by Preuss for a fungus now unknown invalidates that name as used by Epstein. Careful study of Epstein's article and of the diagnosis of *P. Epsteinii*, drawn by Lindau from Epstein's article, shows that this description offered would be incorrect if applied to this fungus. This opinion has been discussed with and concurred in by Dr. C. Wehmer.

few basidia which bear long loosely divergent chains of conidia. Basidia $8-11 \times 2.4-3 \mu$. Conidia at first cylindrical then elliptical and finally globose when ripe, smooth bluish-green by transmitted light, thin-walled and commonly guttulate, $4.5-5.5 \mu$ in diameter, swelling in germination to $8-10 \mu$. Germ-tubes one to several. Cells of mycelium about 5 by $20-40 \mu$. Liquefies sugar gelatine only under the center of the colony. Changes blue litmus to red strongly at first, then after four to six days begins to turn the red back to blue at the center and continues outward concentrically until all has become blue. Growing and fruiting period about two weeks. Fruits only upon *exposed surfaces* of the substrata—never produces spores in cavities not very broadly open. Habitat, Camembert and other soft cheeses.

THE ROQUEFORT MOLD.

The spores of the Roquefort mold grow very rapidly, often producing new mycelium and ripe spores within thirty-six hours. The colonies are white at the very first but begin to become green at the center within two days in a rapidly growing colony. Such a colony may become a half inch in diameter in the first two days. The mycelium is mostly submerged but very close to the surface and grows rapidly outward from the starting point in a radial manner, which is rendered prominent by certain of the threads lying just under the surface for the most part, but making loops into the air by rising just above the substratum for a little way then reëntering the medium. This gives a greyish, almost cobwebby (arachnoid) appearance to the margin of the young colony. The rate of growth is not uniform in the circumference of such a colony, which makes the border of a colony uneven instead of regularly circular as most species appear. The superficial portion of the Roquefort mold is almost entirely composed of the fruiting hyphae or conidiophores, the vast majority of which arise as branches of submerged hyphae and consequently stand separately as short unbranched threads of approximately equal length, which give the surface a velvety appearance. They are usually two or three tenths of a millimeter or less in length, say one seventy-fifth of an inch. Such a colony spreads indefinitely in the substratum so that the center will be composed of ripe fruit while the margin is still actively growing. In

laboratory culture, however, the development is so rapid that the entire surface is covered within the first few days, then growth ceases. The mycelium here, as in the Camembert mold, produces but a single crop of spores, then dies. These spores are a bright green at first, but in a short time become a dirty brown color in dry culture. The spores of this fungus are much more resistant than those of the Camembert mold both to heat and to natural exposures. They will retain their viability for months in old cultures, under the ordinary conditions of exposure in the laboratory. Upon a cheese this mold produces a bright green area which extends rapidly. Its action can be detected in a few days by the bitter taste of the curd near to the mycelium. A similar taste is, however, produced at least in some measure by other green forms so that it is not diagnostic except as between this and the Camembert species. A colony upon the surface of a cheese becomes brown in two or three weeks, but colonies growing in the cavities which are so characteristic of the center of this type of cheese retain their bright green color for long periods.

This mold is not limited to dairy products, but is widely distributed. It has been sent to the laboratory from the most distant correspondents. It has been found in silage, in laboratory cultures from many substances. It has been found to be the green mold of Stilton, Gorgonzola and Brinse, as well as in certain types of prepared cheese purchased in the market. Once in a laboratory it stays and seems to get into everything. In other words this is one of the cosmopolitan and omnivorous species of the genus. One character seems to differentiate this mold from most of the others—that is, its power of growing into and fruiting normally within narrow cavities, such as appear in cheese. It appears that this character exerts a sort of automatic (perhaps we may call it a truly “natural”) selection which eliminates all other species from the ripening processes of Roquefort and related types of cheese.

A technical characterization, based upon petri dish cultures in gelatin and agar, is offered:

Penicillium roqueforti (*nomen novum*).^{*}—Colonies quickly turning green, becoming a dirty brown in age, velvety strict, indeterminately spreading by large main radiating, branching hyphae giving a somewhat uneven or indefinite margin, which gets a white, fibrous, almost spider-web appearance from its alternation of submerged parts of hyphae with short prostrate aerial loops; reverse of colony yellowish white. Conidiophores arising separately and in acropetal succession from the growing parts of submerged hyphae (comparatively few from aerial parts, but some), 200-300 μ septate. Fructification 90-120 μ or at times 160 μ by 30-60 μ at broadest place, usually appearing double by the divergence of the lowest branch, branchlets (basidiophores) irregularly verticillate bearing crowded verticils of appressed basidia, 9-11 by 2.5 μ , with long divergent chains of conidia. Conidia bluish-green, cylindrical to globose, smooth, rather firm walled, 4-5 μ in diameter, germinating by a straight tube. Colonies do not liquefy sugar gelatine though they soften it somewhat. Fungus changes litmus from red to blue very rapidly and strongly almost from the beginning of growth. Fruiting period short, but one crop of spores upon the mycelium. Cosmopolitan and omnivorous, or nearly so. Characteristic of Roquefort and related types of cheese. Fig. 2.

OIDIUM LACTIS.

The mold variously known as *Oidium* or *Oospora lactis* is another cosmopolitan organism. This fungus differs widely from the species previously described. Inoculated into any suitable medium it grows with enormous rapidity. A single spore (or oidium) may give rise to several centimeters of mycelium and hundreds of spores in twenty-four hours. It prefers very moist situations, since almost the entire mycelium is developed below the surface of the substratum. It is therefore passed unnoticed many times or produces changes which are attributed by the observer to bacteria. Description therefore must depend upon microscopic characters. The study of the border of the young colony shows numerous vegetative hyphae radiating outward. Each of these is found to divide dichotomously (fig. 3, a, b) so that the border is a crowded series of forking branches. In the older parts of the mycelium a branch

^{*} The mold of Roquefort cheese is referred to in the literature only as *P. glaucum*. Careful study shows that this species has been confused with numerous others under the name *P. glaucum*. The unique position of this mold and its very distinct characters make it very desirable to have the name proposed above, *Penicillium roqueforti*.

may be produced at each end of every cell, or several at each end, and these branch indefinitely. The fruiting branches are mostly produced as outgrowths from the distal ends of the cells. These extend upward into the air or remain entirely submerged in many cases. From the ends of these outgrowths one to several rows of oblong or cylindrical cells begin to be pinched off. If extending above the surface this gives rise to chains of delicate shimmering cells which appear as a powdery covering upon the surface, which can be seen with a good lens to be arranged into chains. In some strains of *Oidium* all of these chains (and some of the chains in all strains) of spores remain submerged and germinate at once, so that they give rise to unintelligible mats of hyphae. *Oidium* produces a very slight acid reaction to litmus at first, then a strong and continued alkaline reaction. It liquefies sugar gelatine under the colonies, but does not extend the area of liquefaction beyond the edge of the colony. *Oidium* always and everywhere tested has produced a strong and very characteristic odor. Once familiar with this odor the worker may recognize it anywhere. Its spores or oidia are hyaline, smooth, cylindrical, 3.5-5 by 6-30, varying with the conditions and the substratum and perhaps at times exceeding these limits. These swell variously and germinate in many ways so that no germination characters are definite. Upon some media this mold may be induced to produce a large growth of aerial mycelium, but the limits here defined will include the variations to be found upon the usual culture media.

Oidium lactis is described as universally present on milk and its products. Epstein even suggests that experiments upon milk and cheese can not be freed from its presence without sterilizing. The same or almost indistinguishable forms are found upon decaying vegetables and fruits, which may give reason for the statement that the odor produced by *Oidium* is that of rotten cabbage. There seems to be good reason for saying that all these forms are but varieties or strains of the same species. Comparison of several of them shows that under uniform conditions the morphology of all these forms is very nearly the same. This is also largely true of their physiological effects. This mold has been much studied and numerous papers discuss its nature and physiological effects as well as its

relationship. It will be sufficient to describe here the fungus and to give figures to assist in its recognition. Its relations to the problems of cheese ripening have already been indicated.

SUMMARY OF THE RELATIONS OF FUNGI TO CHEESE RIPENING AS SHOWN IN THIS PAPER.

1. *Camembert Cheese*.—The acidity of the curd resulting from the action of lactic organisms reduces where it does not entirely eliminate the growth of objectionable bacteria.

2. Many species of dairy fungi exert in the course of their development the power of changing this reaction to alkaline. The *Camembert Penicillium* and *Oidium lactis* possess this power but not in greater degree than many other species.

3. Many species of fungi produce proteolytic changes in curd to a greater or less extent.

4. The chemical changes in the ripening of curd by fungi are due in the cases studied to the production of enzymes.

5. The texture, appearance and flavor of curd acted upon by such fungi are different for different species.

6. The *Camembert Penicillium* (*P. Camemberti*) is the only species so far studied with which the particular appearance and texture sought in the ripened *Camembert* can be produced from curd soured by lactic bacteria, without producing any objectionable flavor.

7. *Oidium lactis* is always found upon *Camembert* cheese and so closely associated with the presence of the flavor as to suggest its agency in flavor production though only circumstantial proof of such a function has been possible thus far. The participation of bacteria in flavor production is not excluded by these results.

8. Other species of fungi have been shown to produce variations in this flavor such as have been often found in certain market cheeses. In this way it is possible to look for the cause of differences in flavor in contamination of the cultures upon the cheeses. This points toward the use of pure cultures for inoculation with the addition of special organisms if certain variations from what we have regarded as typical flavor are found to be of value in the market, rather than dependence upon accidental occurrence of the desired species in the factory.

9. *Roquefort Cheese*.—In the ripening of Roquefort cheese the only organisms found necessary are lactic bacteria and the Roquefort species of *Penicillium*.

10. The Roquefort *Penicillium* has been shown to possess the power to reduce the acidity, to change the chemical nature of the curd, and to produce the typical flavor.

11. *Other Varieties of Cheese*.—The Roquefort species of *Penicillium* is found to be present in the imported Stilton, Gorgonzola and Brinse, as well as Roquefort cheese.

12. *Oidium lactis* alone of the forms studied has been found upon the various brands of Limburger, Brie (American type), Isigny and related cheeses found in the market. Other species incidentally occur but not uniformly, and such occurrence is avoided as far as possible by the makers.

Fig. 1.—Camembert Penicillium (P. camemberti):

- a, conidiophore showing a common type of branching and the production of basidia and conidia, highly magnified.
- b, a common form showing much less branching.
- c, d, f, diagrams of large fructifications (x 80).
- g, j, i, germinating conidia.

Fig. 2.—Roquefort Penicillium (P. roqueforti):

- a, part of conidiophore and base of fructification highly magnified showing the production of basidia on the sides as well as at the apex of the basidiophore.
- b, c, other types of branching.
- d, young conidiophore just branching.
- e, f, basidia and the formation of conidia, highly magnified.
- g, h, j, diagrams of types of fructification as seen under low power (x 30).
- k, l, m, n, germination of conidia and new conidia produced directly on the first hyphae.

Fig. 3.—Oidium Lactis:

- a, b, dichotomous branching of growing hyphae.
- c, d, g, simple chains of oidia breaking through substratum at dotted line xy, dotted portions submerged.
- e, f, chains of oidia from a branching outgrowth of a submerged cell.
- h, branching chain of oidia.
- k, l, m, n, o, p, s, types of germination of oidia under varying conditions.
- t, diagram of a portion of a colony showing habit of *oidium lactis* as seen in culture media.

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EXPERIMENTS ON THE DIGESTIBILITY OF FISH AND POULTRY.

BY R. D. MILNER.

The present article is a report of digestion experiments with poultry and fish which form part of the nutrition investigations carried on by the Station during the year 1904 in coöperation with the United States Department of Agriculture.

The object of these experiments was to obtain information regarding the actual nutritive value of poultry and fish. It has been explained in previous reports of this Station that for the proper estimation of the nutritive value of any food material, it is not sufficient to consider merely its percentage composition, that is, the amount of the different nutritive ingredients it contains. It is necessary to consider also its digestibility, or the amount of each ingredient that will be digested and absorbed, and so made of use to the body for the purposes of nutrition—the building of tissue, and the yielding of energy. Thus, two foods might be very much alike in chemical composition and yet, because of differences in digestibility, differ widely in actual nutritive value. This is known to be the case with graham and white flours. If these two grades of flour are milled from the same lot of wheat, their composition is found to be much the same, there being a little more protein in the graham than in the white flour. Bread made from the white flour, however, is much more completely digested than that from the graham flour. As a result the body actually obtains more nourishment from a given quantity of white flour than from the same quantity of graham flour.

Considerable information is now available concerning the digestibility of mixed diets in general, and of several different classes of food materials. As suggested just above, study has already been made of the digestibility and relative nutritive value of different grades of wheat flour. Experiments with

various cereal breakfast foods, with macaroni, with vegetables, legumes and with fruit and nuts may also be cited. Studies have also been made of the digestibility of milk, and of various meats, especially beef. The data at hand, however, are by no means complete, and in view of the importance of definite knowledge, much attention is now being given to this phase of the subject.

As regards the digestibility of poultry and fish but little is known. Analyses of these foods are extensive, and their chemical composition is well understood. The first at all elaborate series of investigations of food materials undertaken in this country were studies made by Atwater under the auspices of the U. S. Fish Commission, in 1878-81, on the chemistry of fish. The report of this Station for 1902 contained a large number of analyses of poultry. No attempt is here made, however, to summarize previous investigations. The object is merely to make a contribution to the general knowledge of the subject, which, so far as the digestibility of these foods is concerned is very meagre.

DETAILS OF THE EXPERIMENTS.

The work here reported comprises four series of experiments, two with fish and two with poultry. Each series consisted of four experiments, so that in all sixteen experiments were included. It was the purpose in the investigation, not only to ascertain the extent to which fish and poultry are digested, but also to compare, as far as possible, the digestibility of relatively fat and lean species. In the experiments with fish, salmon was used as a type of relatively fat fish, and cod as a type of lean fish. In the experiments with poultry, duck and chicken were similarly selected.

In the first series of experiments a simple ration was made up consisting of salmon, bread, milk, butter and sugar. This was consumed by each of the subjects for three days. The remaining series of experiments followed immediately, on essentially the same diet, save that chicken, cod and duck were substituted in turn for the salmon. All the food consumed and feces excreted during each experiment were carefully weighed and samples analyzed. The urine of the final day of each experiment was also collected, weighed, and its heat of

combustion determined. From the data thus obtained, the availability of the diet as a whole and of the fish or poultry alone was calculated as explained more fully beyond. The details of the separate experiments follow.

Subjects.—The subjects of the sixteen experiments were four men ranging from 19 to 38 years of age and from 60 to 75 kilograms in weight. All were engaged in light work in connection with the nutrition investigations. Each one took some physical exercise each day, the total daily amount of muscular activity being probably on the average about equivalent to that of a man at light muscular work. No attempt was made, however, to secure uniformity. The men simply pursued their ordinary course of life except as regards diet.

All the subjects were in good physical condition, with apparently normal digestion. Two of them, E. O. and R. D. M., had previously been subjects of digestion experiments, and the other two, from their experience in the laboratory, fully understood the nature and requirements of such experiments.

Duration.—In digestion experiments, as long periods as practicable are desirable, since thereby any error, as in the separation of the feces pertaining to the digestion period, would be minimized. In these experiments the period was in each case three full days.

Diet.—In these experiments the diet consisted of the food under investigation, together with bread, sugar, milk, butter, and in some experiments duck-fat and rock-candy. No restriction was placed upon the amount of any food material to be eaten, each subject choosing what seemed to him to be sufficient to satisfy his needs. Some of the subjects endeavored to secure uniformity from meal to meal of at least a portion of the diet.

In order to compute the availability of the fish and poultry alone, as hereafter explained, the diet was purposely made as simple as possible consistent with palatability. Theoretically, an ideal diet for such experiments would consist of only the material studied; but such a diet, as pointed out in a previous report,* would not be practicable, and it is believed that results obtained by the methods here reported indicate more closely

* Storrs Expt. Sta. Rpt. 1904, p. 183.

the digestibility of these materials in the ordinary mixed diet, than would experiments in which the diet was limited to a single material.

Description of food materials.—In these experiments, well known brands of canned salmon and canned chicken were purchased at a local grocery. No preparation was necessary, other than the removal of a small amount of bone and other refuse from the chicken, and the materials were then eaten as purchased.

As a type of lean fish, fresh cod was selected. Several fresh cod steaks were purchased each day, cut into small pieces and prepared by frying. The pan was slightly greased with butter, and the fish thoroughly mixed with a knife during the cooking.

The duck used as a type of fat poultry was purchased uncooked, and prepared by roasting. The fat which cooked out in the process was carefully saved, and constituted the "duck-fat" hereafter referred to.

The bread was ordinary white bread purchased of a local baker, and was left at the laboratory each day. Immediately after purchase, it was stored in large glass jars in a cool place.

The milk used was from a mixture of the total product of several cows of a local herd. Milk from the same cows was included each day, as previous experience had indicated little variation in composition of such milk from day to day.

The butter was purchased at a local grocery, a fresh supply being obtained for each series of experiments.

The sugar was granulated cane sugar and was obtained at a local grocery. The rock-candy was a portion of a supply kept on hand for combustion work with bomb calorimeter.

Sampling of food.—As previously stated, the chicken and salmon were purchased in cans. At the beginning of the series of experiments, each subject was given one of these cans. At the first meal, each subject opened his can, transferred the contents to a large weighed bowl, and secured as thorough mixing as possible by stirring with a large spoon. Portions as nearly equal as could be easily estimated were then taken from each bowl for a sample for analysis. This procedure was

followed at the opening of each new can, and the composite sample thus obtained, after thorough mixing, was analyzed as representing the composition of the material.

Samples of the cod were taken from each portion fried, care being taken to secure a representative sample in each case. The mixture of the samples thus obtained was then analyzed.

The sample of duck was obtained by removing the meat from the cooked birds and carefully shredding it into as small pieces as possible. After thorough mixing, a portion was then removed for analysis.

The milk and bread were obtained fresh each morning, and aliquot portions of each were taken. The samples for all the days of an experiment were then mixed together and formed a composite sample for analysis. In the case of the milk, a few drops of formalin were added to the composite sample as a preservative.

Since the butter was purchased in amounts sufficient for an entire series of experiments, a sample was taken at only the beginning of each series. A single sample of the duck-fat was likewise sufficient.

No analyses were made of the sugar or rock-candy, as these materials are known to be of uniform composition.

Separation of feces.—In these experiments, separation of the feces pertaining to the experimental period was effected by means of lamp-black in gelatin capsules, taken with the first meal of each experiment and the first meal following the completion of the series, according to the method explained in detail in a former report.* In most cases the separations were quite satisfactory, though in some cases the line of demarcation in the separation at the end of an experiment was not so sharply defined as is desirable.

The feces pertaining to each experiment were collected, dried, weighed and ground for analysis.

Collection of urine.—The urine was collected for twenty-four hours of each experiment, beginning at 7 A. M. of the third day and ending at 7 A. M. of the day following. In the absence of any means of separating the urine pertaining to the experimental period and the lack of definite knowledge concerning

* Storrs Expt. Sta. Rpt. 1904.

the nitrogen lag, *i.e.*, the time elapsing between the ingestion of nitrogen in the food and its elimination in the urine, it was considered that this period could be taken as fairly representing the daily protein katabolism on the experimental diet.

The weight and heat of combustion of the urine were determined, and used in the computations of available energy, as explained beyond.

Analyses of food, feces and urine.—The analyses of the food materials and feces were made according to the methods adopted by the Association of Official Agricultural Chemists.* In the duck-fat sample, only the water content was determined. The ash content of the butter samples was assumed to be 2.50 per cent. in each case. Fat, in both the duck-fat and butter samples, was estimated by difference. Protein was taken throughout as equal to $N \times 6.25$.†

The heats of combustion were made in the usual way by means of the bomb calorimeter.‡ The composition and heats of combustion of food materials and feces and the heats of combustion of the urine are given in Table 12.

From the table it will be noted that the most striking differences between the fish and poultry samples were as regards fat. The duck contained 28.43 per cent., the chicken and salmon nearly one-half, and the cod less than one-sixth of this amount. The amount of fat in fresh cod in fact has been shown by analyses elsewhere to be very small, averaging about .5 of one per cent. In this case, the higher fat content is due to the butter used in the frying.

As regards protein, the poultry was somewhat richer, the difference being about 6 per cent. The heat of combustion of the duck was highest, 4.244 calories per gram, that of the chicken and salmon about 2.6 calories per gram and that of the cod 1.616 calories per gram. The fact should not be lost sight of, however, that the composition of all these materials may be modified to a considerable extent, especially as regards water

* U. S. Dept. Agr., Division of Chemistry, Bul. 46, revised.

† For strict accuracy, the protein of bread should be taken as $N \times 5.70$, and that of total feces as the sum of the nitrogen from bread $\times 5.70$ and the nitrogen from other sources $\times 6.25$. Such a change, however, would not appreciably affect the coefficients of availability, and the use of the factor 6.25 secures uniformity with previous work.

‡ Journ. Amer. Chem. Soc. Vol. 25, No. 7 (1903), p. 659.

TABLE 12.

Percentage composition of food and feces and heat of combustion of food, feces and urine in digestion experiments Nos. 598-613.

Sample No.	KIND OF MATERIAL.	Water.			Protein (N X 6.25)	Fat.	Carbohydrates.	Ash.	Heat of Combustion per Gram.
		%	%	%					
3733	Salmon, - - - -	62.10	21.36	13.53	—	—	2.45	2.452	
3749	Cod, - - - -	72.33	22.05	4.52	—	—	1.79	1.616	
3741	Chicken, - - - -	57.20	28.57	11.60	—	—	2.40	2.780	
3757	Duck, - - - -	41.75	27.15	28.43	—	—	1.87	4.247	
3734	Bread, - - - -	35.85	8.75	3.91	50.56	.93	2.936		
3750	Bread, - - - -	33.94	8.69	4.06	52.26	1.05	3.093		
3742	Bread, - - - -	35.64	8.87	3.72	50.77	1.00	2.991		
3758	Bread, - - - -	33.02	9.13	4.07	52.90	.88	3.080		
3735	Milk, - - - -	87.78	3.15	1.73	6.99	.35	.697		
3751	Milk, - - - -	87.46	3.08	3.71	5.04	.71	.725		
3743	Milk, - - - -	87.40	3.20	3.73	4.95	.72	.726		
3759	Milk, - - - -	86.13	2.97	4.01	6.11	.78	.798		
3736	Butter, - - - -	11.96	.69	84.85	—	a2.50	7.517		
3752	Butter, - - - -	13.83	.56	83.11	—	a2.50	7.678		
3744	Butter, - - - -	9.71	.56	87.23	—	a2.50	7.626		
3760	Duck-fat, - - - -	36.52	—	63.48	—	—	5.251		
—	Sugar, - - - -	—	—	—	a100.00	—	a3.960		
—	Rock-candy, - - - -	—	—	—	a100.00	—	a3.960		
3738	Feces (partially dried), - - - -	6.15	32.00	22.68	20.17	19.00	5.494		
3737	Feces (partially dried), - - - -	7.07	44.50	20.37	16.17	11.80	5.740		
3740	Feces (partially dried), - - - -	5.11	29.38	24.40	19.04	22.07	5.389		
3739	Feces (partially dried), - - - -	5.54	32.69	17.74	25.39	18.64	5.288		
3754	Feces (partially dried), - - - -	7.91	46.50	21.07	11.57	12.95	5.439		
3753	Feces (partially dried), - - - -	10.52	48.19	18.33	14.32	8.64	5.530		
3756	Feces (partially dried), - - - -	7.69	32.31	22.41	17.39	20.20	5.135		
3755	Feces (partially dried), - - - -	7.25	30.75	21.45	22.00	18.55	5.222		
3746	Feces (partially dried), - - - -	11.63	37.19	17.28	18.79	15.11	5.353		
3745	Feces (partially dried), - - - -	8.62	51.23	18.35	15.09	6.71	5.862		
3748	Feces (partially dried), - - - -	3.96	27.13	22.27	26.36	20.28	5.764		
3747	Feces (partially dried), - - - -	7.50	33.81	18.55	22.23	17.91	5.380		
3762	Feces (partially dried), - - - -	7.35	42.88	31.08	8.95	9.74	6.027		
3761	Feces (partially dried), - - - -	7.64	47.06	23.00	15.02	7.28	5.753		
3764	Feces (partially dried), - - - -	5.70	35.88	26.18	15.79	16.45	5.462		
3763	Feces (partially dried), - - - -	5.82	34.00	34.35	10.48	15.35	5.727		
—	Urine, Exp. 598, - - - -	—	—	—	—	—	.153		
—	Urine, Exp. 599, - - - -	—	—	—	—	—	.190		
—	Urine, Exp. 600, - - - -	—	—	—	—	—	.103		
—	Urine, Exp. 601, - - - -	—	—	—	—	—	.158		
—	Urine, Exp. 602, - - - -	—	—	—	—	—	.187		
—	Urine, Exp. 603, - - - -	—	—	—	—	—	.164		
—	Urine, Exp. 604, - - - -	—	—	—	—	—	.109		
—	Urine, Exp. 605, - - - -	—	—	—	—	—	.133		

TABLE 12.—(Continued).

Sample No.	KIND OF MATERIAL.	Water.	Protein (N×6.25)	Fat.	Carbohydrates.	Ash.	Heat of Combustion per Gram.
		%	%	%	%	%	Cal.*
—	Urine, Exp. 606, - - -	—	—	—	—	—	.132
—	Urine, Exp. 607, - - -	—	—	—	—	—	.154
—	Urine, Exp. 608, - - -	—	—	—	—	—	.133
—	Urine, Exp. 609, - - -	—	—	—	—	—	.097
—	Urine, Exp. 610, - - -	—	—	—	—	—	.152
—	Urine, Exp. 611, - - -	—	—	—	—	—	.169
—	Urine, Exp. 612, - - -	—	—	—	—	—	.121
—	Urine, Exp. 613, - - -	—	—	—	—	—	.131

* The unit of energy is taken as the large Calorie, *i. e.*, the quantity of heat necessary to raise one kilogram of water one degree centigrade.

a Assumed.

content, by the method of preparation, though it seems probable that these analyses fairly represent the average composition of these materials as ordinarily eaten.

The milk samples were found to vary considerably, especially as regards fat. The reason for this is not entirely clear. It is possible that it is to be explained by incomplete mixing, either before delivery or in sampling.

The samples of bread and butter show as great uniformity as would be expected.

DATA OF THE EXPERIMENTS.

In these experiments no attempt was made to secure uniformity among the subjects as to either the kind or amount of food eaten from meal to meal. Thus, one of the subjects took no milk during most of the experiments, while with some of the other subjects it formed a very large part of the diet. Even the fish or poultry was occasionally omitted from a single meal. In all cases, however, it will be noted that the food under investigation made up a considerable proportion of the diet.

The subjects took their meals together in the laboratory, following as closely as possible their accustomed hours. In the experiments with salmon and chicken each subject, as already

explained, put an entire can of the salmon or chicken into a weighed bowl. After the removal of a portion for analysis, the bowl and contents were weighed. During the day the subject consumed as much of the material as he desired, the exact amounts being determined by difference by reweighing the bowl at the close of the day. A similar procedure was followed in the case of the duck.

The amounts eaten of cod, bread, milk, duck-fat and rock-candy were determined by direct weighing at each meal. Sugar was in most cases determined by weighing the bottle at the beginning and end of the experiment. Definite amounts of butter were weighed out when desired, and consumed from time to time.

All weighings taken were checked by another subject, thereby reducing the chances of error to a minimum.

TABLE 13.

*Amounts of food, feces, and urine in digestion experiments
Nos. 598-613.*

Experiment No.	SUBJECT.	DIET.	FOOD EATEN.						Feces (partially dried).	Urine (third day).
			Fish or Poultry.	Bread.	Milk.	Butter.	Sugar.	Duck-fat.		
			Gms.	Gms.	Gms.	Gms.	Gms.	Gms.		
598	R.D.M.	Salmon, etc.	1138.9	923.5	2000.0	120.0	107.0	—	55.2	1039.2
599	H.C.M.	Salmon, etc.	1150.4	698.1	400.0	100.0	75.6	—	46.2	924.9
600	E.O.	Salmon, etc.	1272.8	900.0	2700.0	150.0	145.8	—	70.5	1490.5
601	E.M.S.	Salmon, etc.	1254.8	704.7	2700.0	50.0	107.3	—	64.9	1032.5
602	R.D.M.	Cod, etc.	891.4	950.0	1050.0	150.0	135.9	—	43.2	709.8
603	H.C.M.	Cod, etc.	1215.6	883.0	—	150.0	125.4	—	45.5	1142.7
604	E.O.	Cod, etc.	1365.9	675.0	2700.0	150.0	119.3	—	61.8	1685.5
605	E.M.S.	Cod, etc.	908.3	745.7	3600.0	115.0	192.2	—	58.3	6972.0
606	R.D.M.	Chicken, etc.	964.3	900.0	1800.0	125.0	153.0	—	47.1	1273.8
607	H.C.M.	Chicken, etc.	1029.6	788.2	—	120.6	76.9	—	56.7	1145.1
608	E.O.	Chicken, etc.	1328.0	500.0	2700.0	150.0	169.1	—	54.4	1362.0
609	E.M.S.	Chicken, etc.	1030.2	585.0	3200.0	50.0	159.2	—	47.1	1903.7
610	R.D.M.	Duck, etc.	795.3	800.0	800.0	—	188.7	409.4	50.7	809.5
611	H.C.M.	Duck, etc.	889.8	717.5	—	—	119.3	419.4	49.6	804.6
612	E.O.	Duck, etc.	1061.7	600.0	2100.0	—	105.8	234.5	59.6	1351.8
613	E.M.S.	Duck, etc.	747.5	724.8	3000.0	—	2235.3	188.3	60.4	1043.9

a Includes 31.5 grams of rock-candy.

b Lost about 25 grams by upsetting the bottle.

In Table 13 the amounts of the various foods eaten during the experiments are given, together with the weights of the partially dried feces and of the urine of the third day. The weights of fresh feces are not given since the analyses were made on the partially dried samples, and the computations of nutrients may be made from these data, irrespective of the total water content.

CALCULATION OF RESULTS.

The details of the separate digestion experiments are given in Tables 14 to 17 beyond. The kind and amounts of food eaten are first given as shown by Table 13. These amounts multiplied by their respective percentage composition and heats of combustion (taken from Table 12) give the weight of nutrients and energy in the total diet. In the same way the amounts of nutrients and energy in the partially dried feces are also computed.

Availability of nutrients of the total food.—The difference between the quantities of each nutrient in the total food and the amount of the corresponding nutrient in the feces is assumed to represent the amount digested. Dividing the amount digested by the corresponding amount eaten and multiplying by 100 give the proportion digested on a percentage basis, or as it is generally called, the coefficient of digestibility.

Strictly speaking, the results thus obtained do not represent actual or true digestibility, for the reason that the feces contain not only the portions of food that happen to escape digestion, but also other materials, such as the residues of digestive juices, bacteria, and intestinal debris, which collectively comprise what are commonly designated as metabolic products. To determine true digestibility it would be necessary to separate these metabolic products from the actually digested food, and deduct the ingredients of the latter from those of the food eaten. Thus far, however, no satisfactory method for separating the different constituents of the feces has been devised; consequently the actual digestibility of the food is not easily determined.

On the other hand, since the real object of digestion experiments such as are here reported is to determine what proportion of the food and its several ingredients is actually made available to the body for the purposes of nutrition, the metabolic

products may be considered as representing the cost of digestion in terms of food ingredients. From this point of view the total feces, including both these products and the undigested residue, may be considered as representing the portion of the food unavailable for the building of tissue and the yielding of energy. The difference between the total food and total feces may therefore be designated as the availability of the food. In this discussion, therefore, the term availability is so used, and the coefficients obtained as explained in detail are designated throughout as coefficients of availability.

Availability of nutrients of the fish or poultry alone.—Since the object of these experiments was to ascertain the availability of the fish and poultry alone, the coefficients for this portion of the diet must be determined. For this purpose, the remaining articles in the diet were those the coefficients of availability of which were already known from previous experiments. It was assumed that in the series here reported, their availability would be unchanged. By the use of these coefficients, therefore, it was possible to estimate the amounts of each nutrient of the feces derived from the foods other than fish or poultry. The remainder of the feces could be ascribed to the fish or poultry alone. From these amounts and corresponding weights of each nutrient in the fish or poultry eaten, the coefficients of availability of the fish or poultry could be determined as explained above for the total food.

In making these computations it was assumed that 88 per cent. of the protein of bread, and 97 per cent. of the protein of the milk and butter, and in all cases, 95 per cent. of the fat was available; or in other words, 12 per cent. of the protein of bread and 3 per cent. of the protein of milk and butter, together with 5 per cent. of the fat, was not available and would be found in the feces. This method may be illustrated by the use of figures from one of the experiments.

Thus, in experiment No. 558 (Table 14), with salmon, 80.8 grams of the total protein was supplied by the bread of which 12 per cent. or 9.7 grams was assumed to be not available and so found in the feces. The milk and butter supplied 63.8 grams of protein, of which 3 per cent. or 1.9 grams would be found in the feces. The total protein in the feces from the

food other than salmon was therefore 11.6, which, subtracted from the protein of the total feces, gave 6.1 grams as due to the salmon alone. The total protein supplied by the salmon was 243.3 grams, and the amount digested ($243.3 - 6.1$) was 237.2 grams. This quantity, divided by 243.3 grams and multiplied by 100 gave 97.49 per cent. as the coefficient of availability of the protein of salmon alone. The computations for fat were, when practicable, made in the same way.

It will be noted, however, that in several of the experiments the coefficient for fat was not computed. In such cases it was found that the figure obtained, in the manner outlined above, for feces from food other than poultry or fish was larger than the amount actually obtained by analysis for the total feces. The explanation of this discrepancy is to be found in the relatively small amounts of fat found in the feces as compared with the amounts supplied in the food. Under such conditions, a relatively small error in the assumed coefficient may make a considerable difference in the calculated result. In such cases, it has been assumed that the fat of the fish or poultry would have the same coefficient of availability as the total diet.

Since the poultry and fish contained no carbohydrates, it was assumed that the entire carbohydrates of the feces came from the remainder of the diet.

No coefficients of availability of the ash of the poultry and fish were computed, as the coefficients of availability of the ash of the other materials are not known with sufficient accuracy.

Coefficients of availability of energy.—The computations for the availability of the energy differ from the corresponding computations for the nutrients, in that the former show, not the actual availability of the energy to the body, but merely the quantity of energy in the food absorbed from the alimentary canal. It is known that a portion of the protein absorbed is not completely oxidized in the body, since it is excreted in forms like urea, uric acid, etc., which are capable of further oxidation outside the body. Account must therefore be taken of the energy lost to the body in these incompletely oxidized forms.

The method of computation adopted for the total diet was as follows: The energy of the food eaten and of the total feces was found by multiplying the weights of these materials by their heats of combustion per gram. The difference between the energy of food and feces represents the energy of the food as absorbed from the alimentary canal. The amount estimated to be lost to the body through the urine was found by multiplying the heat of combustion of the urine for the experiment by its weight. This gave the amount thus lost for a single day, and multiplied by three, the amount so lost for the entire experiment, since it was assumed that the loss would be constant from day to day. The amount thus lost was subtracted from the total amount absorbed, and the remainder, divided by the total energy of the food and multiplied by 100, gave the coefficients of the energy actually available to the body.

The computation of the available energy of the total diet in experiment No. 598 would therefore be as follows: The total energy of the food, 8224 calories, minus the energy of the feces, 303 calories, gives the energy of the food absorbed from the alimentary canal, 7921 calories. The weight of urine for the third day of the experiment was 1039.2 grams and its heat of combustion .153 calories per gram. The energy lost in the urine for the three days of the experiment was therefore 477 calories ($1039.2 \times .153 \times 3$). This amount, subtracted from the total amount absorbed, 7921 calories, divided by the total energy of the food, 8224 calories, and multiplied by 100, gives 90.52 per cent., the coefficient of availability of the energy of the total food.

The energy of the poultry and fish alone were computed according to the method described in detail in a previous report.* The energy of the feces from food other than poultry or fish was calculated from the weights of protein, fat and carbohydrates contained. The factors used were those elsewhere† computed as the heats of combustion of the nutrients in an ordinary mixed diet, viz., protein 5.65 calories, fat 9.4 calories, and carbohydrates 4.15 calories per gram. It was then assumed that the ratio of the energy of the total feces as calculated by the use of these factors to the energy of the total feces as

* Storrs Expt. Sta. Rpt. 1904, pp. 191-3.

† Storrs Expt. Sta. Rpt. 1899, p. 104.

determined by the bomb calorimeter was the same as the ratio of the calculated energy of the feces from food other than fish or poultry to the required value.

Thus, in experiment No. 598, the computed energy of the total feces was 264 calories and the energy as determined from the heat of combustion 303 calories. The calculated value for the feces from food other than salmon was 192 calories. The proportion was therefore $264 : 303 = 192 : x$, in which case $x = 220$ calories.

The energy of the feces from salmon alone, 83 calories, was found by subtracting this figure from 303 calories. The proportion of energy in the salmon alone which was actually available to the body was then computed as in previous work by assuming that the energy lost to the body was equal to 1.25 times the weight of protein digested from the salmon alone (237.2 grams) or 297 calories. This amount, plus the 83 calories lost in the feces, subtracted from the total energy of the salmon (2793 calories), divided by 2793 calories and multiplied by 100, gave 86.39 per cent. the coefficient of availability of the energy of the salmon alone.

In the following pages the data of the four series of experiments are presented in detail.

EXPERIMENTS WITH SALMON.

The first series of experiments began with breakfast, Feb. 12, and continued three days with nine meals. The food under investigation was canned salmon, selected as a type of fish containing considerable fat. The remainder of the diet included bread, milk, butter, and sugar, though H. C. M. omitted milk, and E. M. S. butter from several of their meals.

The data of the four experiments with salmon are given in Table 14.

EXPERIMENTS WITH COD.

As a type of fish containing relatively little fat, fresh cod steaks were selected. The remainder of the diet included bread, milk, butter and sugar. One of the subjects, H. C. M., consumed no milk during the entire experiment, and the others omitted butter or sugar from one or more meals. R. D. M. consumed no cod at dinner and supper of the third day.

The experiments of this series began with breakfast, Feb. 18, and continued three days with nine meals.

The data of the four experiments with cod are given in Table 15.

EXPERIMENTS WITH CHICKEN.

As a type of relatively lean poultry, canned boned chicken was selected. The remainder of the diet included bread, milk, butter and sugar, though H. C. M. consumed no milk and E. M. S. omitted butter from several meals.

The series of experiments began with breakfast, Feb. 15, and continued three days, with nine meals.

The data of the four experiments with chicken are given in Table 16.

EXPERIMENTS WITH DUCK.

The final series of experiments was with roast duck, selected as a type of fat poultry. The remainder of the diet included bread, milk, sugar, and duck-fat. The duck-fat was that which cooked out of the duck during the roasting, and was eaten cold in the place of butter. H. C. M. consumed no milk during the experiment. On the first day of the experiment, but two meals were eaten, and E. O. restricted his diet to two meals each day. On the second day of the experiment E. M. S. consumed in the place of cane sugar a small amount of rock-candy.

The series of experiments began with breakfast, Feb. 21, and continued three days, with eight meals, except in the experiment with E. O. in which there was six meals.

The details of the four experiments with duck are given in Table 17.

TABLE 14.

Results of digestion experiments with salmon, Nos. 598-601.

DIET:—Salmon, Bread, Milk, Butter, and Sugar.

Sample No.		Weight of Material.	Protein.	Fat.	Carbo-hydrates.	Ash.	Energy.
	<i>Experiment No. 598, with R. D. M.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3733	Salmon, - - - - -	1138.9	243.3	154.1	—	27.9	2793
3734	Bread, - - - - -	923.5	80.8	36.1	466.9	8.6	2711
3735	Milk, - - - - -	2000.0	63.0	34.6	139.8	7.0	1394
3736	Butter, - - - - -	120.0	0.8	101.8	—	3.0	902
	Sugar, - - - - -	107.0	—	—	107.0	—	424
	Total, - - - - -	—	387.9	326.6	713.7	46.5	8224
3738	Feces from total food, - - -	55.2	17.7	12.5	11.1	10.5	303
	Feces from food other than salmon, - - -	—	11.6	8.6	11.1	—	220
	Feces from salmon alone, - - -	—	6.1	3.9	—	—	83
	Amount digested from total food, - - -	—	370.2	314.1	702.6	36.0	7921
	Amount digested from salmon alone, - - -	—	237.2	150.2	—	—	2710
	Energy of urine from total food, - - -	—	—	—	—	—	477
	Energy of urine from salmon alone, - - -	—	—	—	—	—	297
	Coefficients of availability:		%	%	%	%	%
	Of total food, - - - - -	—	95.44	96.17	98.44	77.42	90.52
	Of salmon alone, - - - - -	—	97.49	97.47	—	—	86.39
	<i>Experiment No. 599, with H. C. M.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3733	Salmon, - - - - -	1150.4	245.7	155.6	—	28.2	2821
3734	Bread, - - - - -	698.1	61.1	27.3	353.0	6.5	2050
3735	Milk, - - - - -	400.0	12.6	6.9	28.0	1.4	279
3736	Butter, - - - - -	100.0	0.7	84.9	—	2.5	752
	Sugar, - - - - -	75.6	—	—	75.6	—	299
	Total, - - - - -	—	320.1	274.7	456.6	38.6	6201
3737	Feces from total food, - - -	46.2	20.6	9.4	7.5	5.5	265
	Feces from food other than salmon, - - -	—	7.7	6.0	7.5	—	147
	Feces from salmon alone, - - -	—	12.9	3.4	—	—	118
	Amount digested from total food, - - -	—	299.5	265.3	449.1	33.1	5936
	Amount digested from salmon alone, - - -	—	232.8	152.2	—	—	2703
	Energy of urine from total food, - - -	—	—	—	—	—	527
	Energy of urine from salmon alone, - - -	—	—	—	—	—	291
	Coefficients of availability:		%	%	%	%	%
	Of total food, - - - - -	—	93.56	96.58	98.36	85.75	87.23
	Of salmon alone, - - - - -	—	94.75	97.81	—	—	85.50

TABLE 14.—(Continued).

Sample No.		Weight of Material.	Protein.	Fat.	Carbohy- drates.	Ash.	Energy.
	<i>Experiment No. 600, with E. O.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3733	Salmon, - - - -	1272.8	271.9	172.2	—	31.2	3121
3734	Bread, - - - -	900.0	78.8	35.2	455.0	8.4	2642
3735	Milk, - - - -	2700.0	85.1	46.7	188.7	9.5	1882
3736	Butter, - - - -	150.0	1.0	127.3	—	3.8	1128
	Sugar, - - - -	145.8	—	—	145.8	—	577
	Total, - - - -	—	436.8	381.4	789.5	52.9	9350
3740	Feces from total food, - - -	70.5	20.7	17.2	13.4	15.6	380
	Feces from food other than salmon, - -	—	12.1	10.5	13.4	—	254
	Feces from salmon alone, - - -	—	8.6	6.7	—	—	126
	Amount digested from total food, - - -	—	416.1	364.2	776.1	37.3	8970
	Amount digested from salmon alone, - - -	—	263.3	165.5	—	—	2995
	Energy of urine from total food, - - -	—	—	—	—	—	461
	Energy of urine from salmon alone, - - -	—	—	—	—	—	329
	Coefficients of availability:		%	%	%	%	%
	Of total food, - - - -	—	95.26	95.49	98.30	70.51	91.01
	Of salmon alone, - - - -	—	96.84	96.11	—	—	85.42
	<i>Experiment No. 601, with F. M. S.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3733	Salmon, - - - -	1254.8	268.0	169.8	—	30.7	3077
3734	Bread, - - - -	704.7	61.7	27.6	356.3	6.6	2069
3735	Milk, - - - -	2700.0	85.1	46.7	188.7	9.5	1882
3736	Butter, - - - -	50.0	.3	42.4	—	1.3	376
	Sugar, - - - -	107.3	—	—	107.3	—	425
	Total, - - - -	—	415.1	286.5	652.3	48.1	7829
3739	Feces from total food, - - -	64.9	21.2	11.5	16.5	12.1	343
	Feces from food other than salmon, - -	—	10.0	5.8	16.5	—	209
	Feces from salmon alone, - - -	—	11.2	5.7	—	—	134
	Amount digested from total food, - - -	—	393.9	275.0	635.8	36.0	7486
	Amount digested from salmon alone, - - -	—	256.8	164.1	—	—	2943
	Energy of urine from total food, - - -	—	—	—	—	—	489
	Energy of urine from salmon alone, - - -	—	—	—	—	—	321
	Coefficients of availability:		%	%	%	%	%
	Of total food, - - - -	—	94.89	95.99	97.47	74.84	89.37
	Of salmon alone, - - - -	—	95.82	96.64	—	—	85.21

TABLE 15.

Results of digestion experiments with cod, Nos. 602-605.

DIET:—Cod, bread, milk, butter, and sugar.

Sample No.		Weight of Material.	Protein.	Fat.	Carbo-hydrates.	Ash.	Energy.
	<i>Experiment No. 602, with R. D. M.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3749	Cod, - - - - -	891.4	196.6	40.3	—	16.0	1441
3750	Bread, - - - - -	950.0	82.6	38.6	496.5	10.0	2938
3751	Milk, - - - - -	1050.0	32.3	39.0	52.9	7.5	761
3752	Butter, - - - - -	150.0	.8	124.7	—	3.8	1152
	Sugar, - - - - -	135.9	—	—	135.9	—	538
	Total, - - - - -	—	312.3	242.6	685.3	37.3	6830
3754	Feces from total food, - -	43.2	20.1	9.1	5.0	5.6	235
	Feces from food other than cod, -	—	10.9	(10.1)	5.0	—	189
	Feces from cod alone, - -	—	9.2	—	—	—	46
	Amount digested from total food, -	—	292.2	233.5	680.3	31.7	6595
	Amount digested from cod alone, -	—	187.4	—	—	—	1395
	Energy of urine from total food, -	—	—	—	—	—	398
	Energy of urine from cod alone, -	—	—	—	—	—	234
	Coefficients of availability:		%	%	%	%	%
	Of total food, - - - - -	—	93.56	96.25	99.27	84.99	90.73
	Of cod alone, - - - - -	—	95.32	96.25	—	—	80.57
	<i>Experiment No. 603, with H. C. M.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3749	Cod, - - - - -	1215.6	268.0	54.9	—	21.8	1964
3750	Bread, - - - - -	883.0	76.7	35.9	461.5	9.3	2731
3752	Butter, - - - - -	150.0	.8	124.7	—	3.8	1152
	Sugar, - - - - -	125.4	—	—	125.4	—	497
	Total, - - - - -	—	345.5	215.5	586.9	34.9	6344
3753	Feces from total food, - -	45.5	21.9	8.3	6.5	3.9	252
	Feces from food other than cod, -	—	9.2	8.0	6.5	—	169
	Feces from cod alone, - -	—	12.7	.3	—	—	83
	Amount digested from total food, -	—	323.6	207.2	580.4	31.0	6092
	Amount digested from cod alone, -	—	255.3	54.6	—	—	1881
	Energy of urine from total food, -	—	—	—	—	—	562
	Energy of urine from cod alone, -	—	—	—	—	—	319
	Coefficients of availability:		%	%	%	%	%
	Of total food, - - - - -	—	93.66	96.15	98.89	88.82	87.17
	Of cod alone, - - - - -	—	95.26	99.45	—	—	79.53

TABLE 15.—*Continued.*

Sample No.		Weight of Material.	Protein.	Fat.	Carbo- hydrates.	Ash.	Energy.
	<i>Experiment No. 604, with E. O.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3749	Cod, - - - - -	1365.9	301.2	61.7	—	24.4	2207
3750	Bread, - - - - -	675.0	58.7	27.4	352.8	7.1	2088
3751	Milk, - - - - -	2700.0	83.2	100.2	136.1	19.2	1958
3752	Butter, - - - - -	150.0	.8	124.7	—	3.8	1152
	Sugar, - - - - -	119.3	—	—	119.3	—	472
	Total, - - - - -	—	443.9	314.0	608.2	54.5	7877
3756	Feces from total food, - - -	61.8	20.0	13.8	10.7	12.5	317
	Feces from food other than cod, -	—	9.5	12.6	10.7	—	240
	Feces from cod alone, - - -	—	10.5	1.2	—	—	77
	Amount digested from total food, -	—	423.9	300.2	597.5	42.0	7560
	Amount digested from cod alone, -	—	290.7	60.5	—	—	2130
	Energy of urine from total food, -	—	—	—	—	—	551
	Energy of urine from cod alone, -	—	—	—	—	—	263
	Coefficients of availability:		%	%	%	%	%
	Of total food, - - - - -	—	95.49	95.61	98.24	77.06	88.98
	Of cod alone, - - - - -	—	96.51	98.06	—	—	80.06
	<i>Experiment No. 605, with E. M. S.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3749	Cod, - - - - -	908.3	200.3	41.1	—	16.3	1468
3750	Bread, - - - - -	745.7	64.8	30.3	389.7	7.8	2306
3751	Milk, - - - - -	3600.0	110.9	133.6	181.4	25.6	2610
3752	Butter, - - - - -	115.0	.6	95.6	—	2.9	883
	Sugar, - - - - -	192.2	—	—	192.2	—	761
	Total, - - - - -	—	376.6	300.6	763.3	52.6	8028
3755	Feces from total food, - - -	58.3	17.9	12.5	12.8	10.8	304
	Feces from food other than cod, -	—	11.1	(13.0)	12.8	—	266
	Feces from cod alone, - - -	—	6.8	—	—	—	38
	Amount digested from total food, -	—	358.7	288.1	750.5	41.8	7724
	Amount digested from cod alone, -	—	193.5	—	—	—	1430
	Energy of urine from total food, -	—	—	—	—	—	388
	Energy of urine from cod alone, -	—	—	—	—	—	242
	Coefficients of availability:		%	%	%	%	%
	Of total food, - - - - -	—	95.25	95.84	98.32	79.47	91.38
	Of cod alone, - - - - -	—	96.61	95.84	—	—	80.93

^a Coefficient assumed to be that of total food as explained on page 127.

TABLE 16.

Results of digestion experiments with chicken, Nos. 606-609.

DIET.—Chicken, bread, milk, butter, and sugar.

Sample No.		Weight of Material.	Protein.	Fat.	Carbo- hydrates.	Ash.	Energy.
	<i>Experiment No. 606, with R. D. M.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3741	Chicken, - - - -	964.3	275.5	111.9	—	23.1	2681
3742	Bread, - - - -	900.0	79.8	33.5	456.9	9.0	2692
3743	Milk, - - - -	1800.0	57.6	67.1	89.1	13.0	1307
3744	Butter, - - - -	125.0	.7	109.0	—	3.1	953
	Sugar, - - - -	153.0	—	—	153.0	—	606
	Total, - - - -	—	413.6	321.5	699.0	48.2	8239
3746	Feces from total food, - -	47.1	17.5	8.1	8.9	7.1	252
	Feces from food other than chicken, -	—	11.7	(10.5)	8.9	—	240
	Feces from chicken alone, - -	—	5.8	—	—	—	12
	Amount digested from total food, -	—	396.1	313.4	690.1	41.1	7987
	Am't digested from chicken alone, -	—	269.7	—	—	—	2669
	Energy of urine from total food, -	—	—	—	—	—	504
	Energy of urine f'm chicken alone, -	—	—	—	—	—	337
			%	%	%	%	%
	Coefficients of availability:						
	Of total food, - - - -	—	95.77	97.48	98.73	85.27	90.82
	Of chicken alone, - - - -	—	97.90	97.48	—	—	86.98
	<i>Experiment No. 607, with H. C. M.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3741	Chicken, - - - -	1029.6	294.2	119.4	—	24.7	2862
3742	Bread, - - - -	788.2	69.9	29.3	400.2	7.9	2358
3744	Butter, - - - -	120.6	.7	105.2	—	3.0	920
	Sugar, - - - -	76.9	—	—	76.9	—	305
	Total, - - - -	—	364.8	253.9	477.1	35.6	6445
3745	Feces from total food, - -	56.7	29.0	10.4	8.6	3.8	332
	Feces from food other than chicken, -	—	8.4	6.7	8.6	—	163
	Feces from chicken alone, - -	—	20.2	3.7	—	—	169
	Amount digested from total food, -	—	335.8	243.5	468.5	31.8	6113
	Am't digested from chicken alone, -	—	274.0	115.7	—	—	2693
	Energy of urine from total food, -	—	—	—	—	—	529
	Energy of urine f'm chicken alone, -	—	—	—	—	—	343
			%	%	%	%	%
	Coefficients of availability:						
	Of total food, - - - -	—	92.05	95.90	98.20	89.33	86.64
	Of chicken alone, - - - -	—	93.13	96.90	—	—	82.11

TABLE 16.—*Continued.*

Sample No.		Weight of Material.	Protein.	Fat.	Carbo-hydrates.	Ash.	Energy.
	<i>Experiment No. 608, with E. O.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3741	Chicken, - - - -	1328.0	379.4	154.0	—	31.9	3692
3742	Bread, - - - -	500.0	44.4	18.6	253.9	5.0	1496
3743	Milk, - - - -	2700.0	86.4	100.7	133.7	19.4	1960
3744	Butter, - - - -	150.0	.8	130.9	—	3.8	1144
	Sugar, - - - -	169.1	—	—	169.1	—	670
	Total, - - - -	—	511.0 ^a	404.2	556.7	60.1	8962
3748	Feces from total food, - -	54.4	14.8	12.1	14.3	11.0	314
	Feces from food other than chicken, - -	—	7.9	(12.5)	14.3	—	270
	Feces from chicken alone, - -	—	6.9	—	—	—	44
	Amount digested from total food, - -	—	496.2	392.1	542.4	49.1	8648
	Am't digested from chicken alone, - -	—	372.5	—	—	—	3648
	Energy of urine from total food, - -	—	—	—	—	—	543
	Energy of urine f'm chicken alone, - -	—	—	—	—	—	465
	Coefficients of availability:		%	%	%	%	%
	Of total food, - - - -	—	97.11	97.01	97.43	81.70	90.44
	Of chicken alone, - - - -	—	98.18	97.01	—	—	86.21
	<i>Experiment No. 609, with E. M. S.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3741	Chicken, - - - -	1030.2	294.3	119.5	—	24.7	2863
3742	Bread, - - - -	585.0	51.9	21.8	297.0	5.9	1750
3743	Milk, - - - -	3200.0	102.4	119.4	158.4	23.0	2323
3744	Butter, - - - -	50.0	.3	43.6	—	1.3	381
	Sugar, - - - -	159.2	—	—	159.2	—	630
	Total, - - - -	—	448.9	304.3	614.6	54.9	7947
3747	Feces from total food, - -	47.1	15.9	8.7	10.5	8.4	253
	Feces from food other than chicken, - -	—	9.3	(9.2)	10.5	—	215
	Feces from chicken alone, - -	—	6.6	—	—	—	38
	Amount digested from total food, - -	—	433.0	295.6	604.1	46.5	7694
	Am't digested from chicken alone, - -	—	287.7	—	—	—	2825
	Energy of urine from total food, - -	—	—	—	—	—	554
	Energy of urine f'm chicken alone, - -	—	—	—	—	—	360
	Coefficients of availability:		%	%	%	%	%
	Of total food, - - - -	—	96.46 ^a	97.14	98.29	84.70	89.85
	Of chicken alone, - - - -	—	97.76	97.14	—	—	86.10

^a Coefficient assumed to be that of total food as explained on page 127.

TABLE 17.

Results of digestion experiments with duck, Nos. 610-613.

DIET:—Duck, Bread, Milk, Duck-fat, Sugar, and Rock-candy.

Sample No.		Weight of Material.	Protein.	Fat.	Carbo-hydrates.	Ash.	Energy.
	<i>Experiment No. 610, with R. D. M.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3757	Duck, - - - - -	795.3	215.9	226.1	—	14.9	3378
3758	Bread, - - - - -	800.0	73.0	32.6	423.2	7.0	2464
3759	Milk, - - - - -	800.0	23.8	32.1	48.9	6.2	638
3760	Duck-fat, - - - - -	409.4	—	259.9	—	—	2150
	Sugar, - - - - -	188.7	—	—	188.7	—	747
	Total, - - - - -	—	312.7	550.7	660.8	28.1	9377
3762	Feces from total food, - - - - -	50.7	21.7	15.8	4.5	4.9	306
	Feces from food other than duck and duck-fat, - - - - -	—	9.5	3.2	4.5	—	109
	Feces from duck and duck-fat alone, - - - - -	—	12.2	12.6	—	—	197
	Amount digested from total food, - - - - -	—	291.0	534.9	656.3	23.2	9071
	Amount digested from duck and duck-fat alone, - - - - -	—	203.7	473.4	—	—	5331
	Energy of urine from total food, - - - - -	—	—	—	—	—	369
	Energy of urine from duck alone, - - - - -	—	—	—	—	—	255
	Coefficients of availability:		%	%	%	%	%
	Of total food, - - - - -	—	93.06	97.13	99.32	82.56	92.80
	Of duck and duck-fat alone, - - - - -	—	94.35	97.41	—	—	91.82
	<i>Experiment No. 611, with H. C. M.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3757	Duck, - - - - -	889.8	241.6	253.0	—	16.6	3779
3758	Bread, - - - - -	717.5	65.5	29.2	379.6	6.3	2210
3760	Duck-fat, - - - - -	419.4	—	266.2	—	—	2202
	Sugar, - - - - -	119.3	—	—	119.3	—	472
	Total, - - - - -	—	307.1	548.4	498.9	22.9	8663
3761	Feces from total food, - - - - -	49.6	23.3	11.4	7.4	3.6	285
	Feces from food other than duck and duck-fat, - - - - -	—	7.9	1.5	7.4	—	94
	Feces from duck and duck-fat alone, - - - - -	—	15.4	9.9	—	—	191
	Amount digested from total food, - - - - -	—	283.8	537.0	491.5	19.3	8378
	Amount digested from duck and duck-fat alone, - - - - -	—	226.2	509.3	—	—	5790
	Energy of urine from total food, - - - - -	—	—	—	—	—	408
	Energy of urine from duck alone, - - - - -	—	—	—	—	—	283
	Coefficients of availability:		%	%	%	%	%
	Of total food, - - - - -	—	92.41	97.92	98.52	84.28	92.00
	Of duck and duck-fat alone, - - - - -	—	93.63	98.09	—	—	92.07

TABLE 17.—(Continued).

Sample.		Weight of Material.	Protein.	Fat.	Carbo- hydrates.	Ash.	Energy.
	<i>Experiment No. 612, with E. O.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3757	Duck, - - - - -	1061.7	288.3	301.8	—	19.9	4509
3758	Bread, - - - - -	600.0	54.8	24.4	317.4	5.3	1848
3759	Milk, - - - - -	2100.0	62.4	84.2	128.3	16.4	1676
3760	Duck-fat, - - - - -	234.5	—	148.9	—	—	1231
	Sugar, - - - - -	105.8	—	—	105.8	—	419
	Total, - - - - -	—	405.5	559.3	551.5	41.6	9683
3764	Feces from total food, - - - - -	59.6	21.4	15.6	9.4	9.8	326
	Feces from food other than duck and duck-fat, - - - - -	—	8.5	5.4	9.4	—	147
	Feces from duck and duck-fat alone, - - - - -	—	12.9	10.2	—	—	179
	Amount digested from total food, - - - - -	—	384.1	543.7	542.1	31.8	9357
	Amount digested from duck and duck-fat alone, - - - - -	—	275.4	440.5	—	—	5561
	Energy of urine from total food, - - - - -	—	—	—	—	—	491
	Energy of urine from duck alone, - - - - -	—	—	—	—	—	344
	Coefficients of availability:		%	%	%	%	%
	Of total food, - - - - -	—	94.72	97.21	98.30	76.44	91.56
	Of duck and duck-fat alone, - - - - -	—	95.53	97.74	—	—	90.89
	<i>Experiment No. 613, with E. M. S.</i>	Gms.	Gms.	Gms.	Gms.	Gms.	Cal.
	Food eaten:						
3757	Duck, - - - - -	747.5	202.9	212.5	—	14.0	3175
3758	Bread, - - - - -	724.8	66.2	29.5	383.4	6.4	2232
3759	Milk, - - - - -	3000.0	89.1	120.3	183.3	23.4	2394
3760	Duck-fat, - - - - -	188.3	—	119.5	—	—	989
	Sugar, - - - - -	203.8	—	—	203.8	—	807
	Rock-candy, - - - - -	31.5	—	—	31.5	—	125
	Total, - - - - -	—	358.2	481.8	802.0	43.8	9722
3763	Feces from total food, - - - - -	60.4	20.5	20.7	6.3	9.3	340
	Feces from food other than duck and duck-fat, - - - - -	—	10.6	7.5	6.3	—	161
	Feces from duck and duck-fat alone, - - - - -	—	9.9	13.2	—	—	185
	Amount digested from total food, - - - - -	—	337.7	461.1	795.7	34.5	9376
	Amount digested from duck and duck-fat alone, - - - - -	—	193.0	318.8	—	—	3979
	Energy of urine from total food, - - - - -	—	—	—	—	—	410
	Energy of urine from duck alone, - - - - -	—	—	—	—	—	241
	Coefficients of availability:		%	%	%	%	%
	Of total food, - - - - -	—	94.28	95.70	99.21	78.77	92.22
	Of duck and duck-fat alone, - - - - -	—	95.12	96.03	—	—	89.77

TABLE 18.

Summary of coefficients of availability of nutrients and energy.

Expt. No.	SUBJECT.		Protein.	Fat.	Carbo- hydrates.	Ash.	Energy.
		<i>Total diet.</i>	%	%	%	%	%
598	R. D. M.	Salmon, etc., - - -	95.44	96.17	98.44	77.42	90.52
599	H. C. M.	Salmon, etc., - - -	93.56	96.58	98.36	85.75	87.23
600	E. O.	Salmon, etc., - - -	95.26	95.49	98.30	70.51	91.01
601	E. M. S.	Salmon, etc., - - -	94.89	95.99	97.47	74.84	89.37
		Average, - - -	94.79	96.06	98.14	77.13	89.53
602	R. D. M.	Cod, etc., - - -	93.56	96.25	99.27	84.99	90.73
603	H. C. M.	Cod, etc., - - -	93.66	96.15	98.89	88.82	87.17
604	E. O.	Cod, etc., - - -	95.49	95.61	98.24	77.06	88.98
605	E. M. S.	Cod, etc., - - -	95.25	95.84	98.32	79.47	91.38
		Average, - - -	94.49	95.96	98.68	82.59	89.57
606	R. D. M.	Chicken, etc., - - -	95.77	97.48	98.73	85.27	90.82
607	H. C. M.	Chicken, etc., - - -	92.05	95.90	98.20	89.33	86.64
608	E. O.	Chicken, etc., - - -	97.11	97.01	97.43	81.70	90.44
609	E. M. S.	Chicken, etc., - - -	96.46	97.14	98.29	84.70	89.85
		Average, - - -	95.35	96.88	98.16	85.25	89.44
610	R. D. M.	Duck, etc., - - -	93.06	97.13	99.32	82.56	92.80
611	H. C. M.	Duck, etc., - - -	92.41	97.92	98.52	84.28	92.00
612	E. O.	Duck, etc., - - -	94.72	97.21	98.30	76.44	91.56
613	E. M. S.	Duck, etc., - - -	94.28	95.70	99.21	78.77	92.22
		Average, - - -	93.62	96.99	98.84	80.51	92.15
		<i>Fish and poultry alone.</i>					
598	R. D. M.	Salmon, etc., - - -	97.49	97.47	—	—	86.39
599	H. C. M.	Salmon, etc., - - -	94.75	97.81	—	—	85.50
600	E. O.	Salmon, etc., - - -	96.84	96.11	—	—	85.42
601	E. M. S.	Salmon, etc., - - -	95.82	96.64	—	—	85.21
		Average, - - -	96.23	97.01	—	—	85.63
602	R. D. M.	Cod, etc., - - -	95.32	96.25	—	—	80.57
603	H. C. M.	Cod, etc., - - -	95.26	99.45	—	—	79.53
604	E. O.	Cod, etc., - - -	96.51	98.06	—	—	80.06
605	E. M. S.	Cod, etc., - - -	96.61	99.84	—	—	80.93
		Average, - - -	95.93	97.40	—	—	80.27
606	R. D. M.	Chicken, etc., - - -	97.90	97.48	—	—	86.98
607	H. C. M.	Chicken, etc., - - -	93.13	96.90	—	—	82.11
608	E. O.	Chicken, etc., - - -	98.18	97.01	—	—	86.21
609	E. M. S.	Chicken, etc., - - -	97.76	97.14	—	—	86.10
		Average, - - -	96.74	97.13	—	—	85.35
610	R. D. M.	Duck, etc., - - -	94.35	97.41	—	—	91.82
611	H. C. M.	Duck, etc., - - -	93.63	98.09	—	—	92.07
612	E. O.	Duck, etc., - - -	95.53	97.74	—	—	90.80
613	E. M. S.	Duck, etc., - - -	95.12	96.03	—	—	89.77
		Average, - - -	94.66	97.32	—	—	91.14

a Assumed as explained on page 127.

SUMMARY AND DISCUSSION OF RESULTS.

In Table 18, above, are summarized the coefficients of availability as found in the preceding experiments. The upper portion of the table gives the coefficients for the nutrients and energy of the total diet, and the lower portion, the coefficients for protein, fat and energy of the fish and poultry alone.

Results for total diet.—In all the experiments, the coefficients for fat and carbohydrates for all four subjects are in close agreement, the greatest variation being in the experiments with duck, in which H. C. M. digested 97.92 per cent. of the fat, and E. O. 95.70 per cent., a difference of 2.22 per cent. In most cases, the variation among the different subjects is less than 1 per cent.

As regards protein and energy, greater variation is found. In the experiments with chicken, the coefficients were for E. O., 97.11 per cent. of the protein and 90.44 per cent. of the energy, while for H. C. M. the coefficients were 92.41 per cent. and 86.64 per cent. respectively, a difference of 4.70 per cent. of protein and 3.80 per cent. of the energy. In general, the agreement was as close as could be expected.

The variations among the different diets were even smaller than those between individual experiments of the same series. The diet seemed to be very thoroughly digested in every case. In some instances, the subjects did not find it particularly palatable, but no difference as to completeness of digestion is to be noted. This would tend further to confirm the results of many experiments both in this country and abroad which indicate that the influence of palatability upon completeness of digestion is less important than is commonly supposed.

Results for the fish and poultry alone.—As already explained in detail, the availability of the fish and poultry alone was computed by assuming that the availability of the remaining articles of the diet would be the same as in other experiments with such materials. The results thus obtained are summarized in the lower portion of Table 18. As has already been explained, in several cases the computations for fat could not be made. In such experiments, the coefficient for the fish or poultry was assumed to be that found for the entire diet.

It will be noted that the separate experiments of each series agree on the whole very closely. The greatest variations are found in the series with chicken, in which the extremes were 98.18 and 93.15 per cent. for protein, and 86.98 and 82.11 per cent. for energy. In most of the other instances, the agreement was within 1 to 2 per cent.

As regards the different series, the variations of the coefficients for fat are remarkably small, the extreme difference in the average being but .39 per cent. It is to be questioned whether such close agreement was not more or less accidental. Apparently, however, the presence of large amounts of fat did not appreciably affect its digestibility.

The average availability of the protein of the different foods varied less than that of the same protein by the four subjects. For the cod and salmon the coefficient was about 96 per cent., for chicken a little higher, and for duck somewhat lower than this figure.

The greatest variation will be noted as regards energy. For salmon and chicken, the coefficients are about 85 per cent., for cod 80 per cent. and for duck 91 per cent. Reference to the composition table shows that the heat of combustion and fat content were highest in the duck sample, about equal for the salmon and chicken, and least in the case of the cod. This may be an indication that the availability of the energy is highest in foods containing a large amount of fat, though the data at hand are not sufficient to warrant too sweeping deductions.

A comparison of the coefficients of availability of the poultry and fish with those of other common foods is given in Table 19, which follows.

TABLE 19.

Availability of nutrients and energy of poultry, fish, and other common foods.

KIND OF FOOD.	Protein.	Fat.	Energy.
	%	%	%
Salmon, - - - - -	96.2	97.0	85.6
Cod, - - - - -	95.9	97.4	80.3
Chicken, - - - - -	96.7	97.1	85.4
Duck, - - - - -	94.7	97.3	91.1
Beef, - - - - -	97.6	96.5	—
Veal, - - - - -	98.0	98.9	—
Mutton, - - - - -	97.1	98.5	—
Pork (fresh ham), - - - - -	99.1	99.4	—
Milk, - - - - -	92.2	96.3	91.3
White Bread, - - - - -	88.1	—	92.0

CONCLUSION.

From the results of sixteen experiments in which canned salmon, fresh cod, canned chicken, and roast duck made up in turn a considerable portion of the diet, it appears that these foods are very completely digested, the coefficients of availability being approximately those previously found for other animal foods. The foods containing a considerable proportion of fat were apparently as completely digested as those in which the percentage of fat was relatively small. The number of kinds of poultry and fish investigated and the number of experiments carried on with each, are too small to warrant further conclusions.

DIETARY STUDIES OF A WEEK'S WALKING TRIP.

BY H. L. KNIGHT.*



The studies summarized in the following report comprise investigations as to the kind and amount of food eaten by two young men of sedentary habit while on a week's walking trip through the White Mountains.

The studies were incidental to the trip itself, which was taken as a means of spending a few days of the summer vacation out of doors in an unfamiliar part of the country. In pursuance of this plan, camp equipage was included in the outfit, and the entire food supply, aside from about two days' rations taken from home at the start, was purchased in as portable a form as possible along the way.

Since the manner of life, and the diet as well, were quite different from those to which the subjects were ordinarily accustomed, it was considered of interest to record the data which are presented in detail beyond.

So far as is known to the writer no studies of precisely this nature have as yet been published. Observations have been made of the food consumption of professional pedestrians, notably Weston, as well as soldiers on the march, bicyclists, college boat crews and others engaged for short periods at severe muscular exercise. Numerous investigations have also been conducted in which subjects without previous training have walked from twenty to fifty miles per day. Thus, in 1882, North, in an experiment reported elsewhere,[†] walked on single days distances of from thirty to forty-seven miles carrying a load of twenty-seven pounds. In most of these researches, however, the diet was restricted as to either the kind or amount of food eaten, and the results, while of value as an index to the body

* The writer desires to express his indebtedness to Mr. C. H. Colletter for his assistance in acting as a subject, and for many valuable suggestions incorporated in the report.

† U. S. Dept. Agr. Office of Experiment Stations Bul. 45. pp. 120, 31.

requirements, afford little information as to the selection of food materials under conditions such as are here presented. An estimate of the food purchased by a canoeing party in Maine has been reported in a compilation of dietary studies by Atwater,* but the amounts of food eaten were not ascertained and the work as a whole is considered unreliable. Data regarding the food consumption of subjects voluntarily walking considerable distances for several days, living entirely out of doors, and depending for their food supply on what could be procured from day to day, appear to be lacking.

THE SUBJECTS.

The subjects were two men, 24 years of age, engaged at sedentary occupations for the entire year except for the summer vacation. One, hereafter referred to as C. H. C., was a college instructor, and the other, H. L. K., the author of this report, was an employee of the U. S. Department of Agriculture and engaged for about eight hours per day in editorial work pertaining to the nutrition investigations. Both ordinarily took comparatively little exercise, though both played tennis and walked short distances as opportunity permitted. Neither subject had ever taken any walk of so extensive a nature, nor had had practical experience in camping or of living for more than a few meals on other than the ordinary diet. Previous to the trip the food consumption of both subjects had been noticeably small.

THE TRIP.

The trip began with a railroad journey of 150 miles to the heart of the White Mountain district and continued for seven days, return being made on the eighth by a similiar trip by rail. In the interval a stretch of about fifty miles was traversed on foot. There were also many detours to points of interest, including several mountain climbs.

The mileage walked was recorded by a pedometer, and showed a total of 157.75 miles, or 22.54 miles per day. It should be stated, however, that in principle the pedometer is a register not of distance but of the number of steps taken, and its accuracy in measuring distance depends upon the uniformity

* Conn. (Storrs) Sta. Rpt. 1902-3, p. 135.

of the length of step. The pedometer used was adjusted for a standard length of step (28 inches), which a test over a known distance had shown to be that ordinarily taken. It seems probable however, that on one or two occasions, as on a particularly severe mountain climb, and again on a jaunt down a railroad track along the ties, the step was perceptibly shortened and the distance measured correspondingly overestimated. Moreover, since the pedometer was carried not merely while on the road, but during the entire day, it registered the many short steps incidental to the building of the camp, preparation of meals, etc. As nearly as could be estimated these were sufficient to average from three to four miles of the total reading for each day, though it is doubtful if an equivalent of more than two or three miles was actually covered in this way. Making due allowance for these inaccuracies, however, it still does not seem possible that the actual mileage could have fallen below 140 miles, or an average of twenty miles per day.

As previously stated, camp equipage was carried sufficient for shelter, preparation of food, etc. Each man's burden was weighed at a time when it was reduced to a minimum, and found to weigh twenty-three pounds. With the amount of food usually carried, this was frequently increased to at least twenty-five pounds per man.

ROUTINE.

The daily program was in general as follows: The subjects rose about daybreak (5 o'clock), took a bath in a nearby stream, had breakfast about 7 o'clock, and broke camp as soon as the luggage was sufficiently dry, which was usually between 8 and 9 o'clock. The average rate of walking was about three miles per hour, with frequent stops for water, rest or observation of the scenery. About 1 o'clock a halt of an hour was made for dinner, after which the walking continued till about 5 o'clock, when a convenient location was sought for a camp. This found, the tent was pitched, and supper prepared and eaten. By the time this was finished and the day's records completed, it was usually dark (8 o'clock) and the subjects turned in at once.

SELECTION AND PREPARATION OF FOOD MATERIALS.

The selection of food materials was governed very largely by circumstances. Rather concentrated food was given the preference, since it was obviously of advantage to carry articles with the least bulk and weight. Goods in packages were preferred to the same articles in bulk. Perishable materials were purchased in as small quantities as possible, and prepared foods were preferred to raw foods. At the same time variety was sought so far as possible, and, when practicable, comparatively bulky foods, like milk and bananas, were used freely. Again, the choice was restricted by necessity to the limited assortment of articles on sale along the route. During the week but one village containing a bakery was passed through, and the remainder of the time it was necessary to rely very largely upon wayside stores, containing, in most cases, little more than a few kinds of fancy crackers, sweet chocolate and birch beer. In a single instance, a summer hotel supplied a camper's lunch. It had been supposed that milk could be readily obtained, in which case it would doubtless have been made use of very largely. It was found, however, that farmhouses were few and for long distances missing altogether. As a result milk was purchased on but three of the eight days. Red raspberries and dwarf blueberries were found by the roadside on several days and were eaten when desired. Where further choice of materials was possible, the deciding test was usually the personal preference of the subjects. The cost of the articles was never a prominent factor, as economy was by no means a primary feature of the trip.

As previously stated, about two days' rations were carried from home. This food was largely in the form of sandwiches, as these were easily prepared and well adapted to the conditions.

The choice of articles for a given meal was decided largely by the same considerations as governed their original selection. Perishable materials, especially meats, were consumed as quickly as possible after opening the original package. Bulky articles likewise were disposed of as speedily as practicable.

Foods requiring cooking were eaten at night and in the morning, as no fire was kindled at noon. Since, as already explained, most of the food materials were purchased ready to

eat, the preparation of food was a comparatively simple matter. Bacon was fried for two meals, and several mornings beef tea was made from the prepared extract, and chocolate from milk chocolate to which was sometimes added several malted milk tablets. The entire amount thus prepared was divided between the two subjects and consumed at once. The amounts of all other food materials consumed at a given meal were regulated entirely by the appetites of the subjects.

From these explanations, it will be apparent that it was in no sense the purpose of the investigation to follow any particular theories as to either kind or amount of food eaten. In fact, aside from the weighing of the food, every effort was made to live exactly as if no dietary study were in progress.

DETAILS OF THE DIETARY STUDIES.

The method employed in conducting these dietary studies consisted in brief in determining the amounts of each food material eaten by each subject during each meal of the trip. From these data, the percentage composition and fuel value of the food materials, and the coefficients of availability, were computed the amounts of total and available nutrients and energy consumed by each subject throughout the experiment. The price paid for each article of food was likewise recorded, and served as a basis for observations as to their relative economy.

Weighing of foods.—The amounts eaten of all solid food materials were for the most part determined by weighing each man's portion on a small hand balance. This balance was considered sensitive to 10 milligrams with a load of 100 grams, but no weight greater than 70 grams was ever put upon it, and weights were taken only to grams as the general conditions of experimenting were not sufficiently exact to warrant greater accuracy. In the case of fancy cookies and similar articles made in molds of the same size and presumably of uniform weight, the above method was simplified by weighing a considerable number of each, assuming that the average weight thus obtained was representative of the entire package, and thereafter recording merely the number eaten. The same plan was also followed for the raspberries and blueberries as a means of obviating many tedious weighings.

All weights and measurements were made and recorded by the writer, who, however, checked his work by noting the weights unused at each weighing. Since the amounts weighed at a time were comparatively small, the chance for serious error was not so great as might appear. A further check, though a rough one, was afforded by securing as accurately as possible the original weight of each package at the time of purchase and then noting the weight of the empty package. As in most cases there was no waste, the difference was obviously the weight of food consumed.

The amounts consumed of liquids, including milk, chocolate, beef tea, birch beer and root beer were estimated by measurement, and the weights then computed. A large amount of water also was drunk, of which no account was taken.

Composition of food materials.—Theoretically, in studies of this kind, each food material used should be sampled and analyzed. This was obviously impracticable under the circumstances, and recourse was had to analyses of similar food materials compiled elsewhere.* It is recognized that the composition of such materials varies widely. This is especially true in the case of cooked foods, because of differences in the recipes used in their preparation. Consequently, the results of these studies must be considered less reliable than those based on actual sampling and analysis. Nevertheless, they serve the purpose for which they were made, and give a fair indication of the food consumption of the subjects.

The following table gives the percentage composition and energy of each material as employed in the computations. The table also includes the amount paid per pound, the materials taken from home at the start being estimated at the prevailing White Mountain prices.

A study of this table reveals anew the fact that the cost of food is a very unreliable indication of its nutritive value. Thus, the malted milk tablets, a proprietary preparation for which extraordinary claims are made and selling at the rate of \$3.50 per pound, actually contain somewhat less of both protein and energy than the deviled ham which was procured in

* U. S. Dept. Agr., Office of Experiment Stations Buls. 28, 152; Division of Chemistry Bul. 13, part 9; Conn. (New Haven) Stations Rpt. 1903, Lab. Inland Rev. Dept., Canada, Bul. 63.

TABLE 20.

Percentage of nutrients, amount of available energy (fuel value) per gram, and cost per pound of food eaten.

	Protein % x 6.25	Fat.	Carbo- hydrates.	Energy (fuel value) per gram.	Cost per pound.
	%	%	%	Cals.	\$
Beef, sandwich meat, - - - -	28.0	11.0	—	2.17	.20
Beef, tongue, canned, - - - -	19.5	23.2	—	2.95	.27
Beef, extract, - - - - -	7.5	.6	—	.96	2.27
Bacon, fried, as eaten, - - - -	22.2	33.2	—	4.00	1.06
Ham, deviled, canned, - - - -	19.0	34.1	—	3.94	.33
Sausage, pork, canned, edible portion, -	16.6	24.8	—	2.98	.33
Chicken, canned, - - - - -	20.8	30.0	—	3.65	.96
Sardines, canned, edible portion, - -	23.0	19.7	—	2.78	.63
Eggs, boiled, edible portion, - -	13.2	12.0	—	1.70	.22
Cheese, full cream, - - - - -	25.9	33.7	2.4	4.30	.34
Milk, whole, - - - - -	3.3	4.0	5.0	.72	.04
Bread, white, home made, - - - -	9.1	1.6	53.3	2.70	.10
Bread, whole wheat, - - - - -	9.7	.9	49.7	2.51	.10
Crackers, butter, - - - - -	9.6	10.1	71.6	4.26	.25
Crackers, cheese filled, - - - - -	9.7	12.1	69.7	4.38	.43
Saltines, - - - - -	10.6	12.7	68.5	4.42	.31
Crispanola,* - - - - -	10.7	5.0	78.7	4.11	.35
Cake, chocolate layer, - - - - -	6.2	8.1	64.1	3.63	.15
Cup cakes, - - - - -	5.9	9.0	68.5	3.90	.09
Cake, sponge, - - - - -	6.3	10.7	65.9	3.95	.15
Cookies, molasses, - - - - -	7.2	8.7	75.7	4.21	.23
Cookies, sugar, - - - - -	7.0	10.2	73.2	4.23	.11
Doughnuts, - - - - -	6.7	21.0	53.1	4.41	.11
Sultanas, - - - - -	6.0	7.4	71.0	3.74	.23
Candy (lime drops, gum drops), - -	—	—	96.0	3.93	.41
Sugar, maple, - - - - -	—	—	82.8	3.39	.20
Bananas, edible portion, - - - -	1.3	.6	22.0	1.01	.12
Huckleberries, - - - - -	.6	.6	16.6	.76	.00†
Raspberries, red, - - - - -	1.0	—	12.6	.56	.00†
Raisins, seeded, - - - - -	2.6	3.3	76.1	3.54	.10
Peanut butter, - - - - -	29.3	46.5	17.1	6.22	.32
Chocolate milk, - - - - -	9.1	31.3	54.3	5.32	1.03
Malted milk tablets, - - - - -	15.2	2.7	76.1	3.89	3.50
Beer (birch and root), - - - - -	—	—	11.2	.45	.08

* Crispanola is a confection consisting chiefly of popcorn, but containing molasses, peanuts and cocoanut. The composition assumed is that of popcorn.

† Not purchased.

packages for 33 cents per pound. The deviled ham likewise supplied about the same nutrients and energy as the fried bacon and at one-third the cost. This was due to the fact that while the original cost was about the same, there was no waste with the ham whereas a large share of the bacon was cooked out in the frying and not utilized. The beef extract, sold at \$2.27

per pound, contained not more than one-fourth to one-third of the energy of the various kinds of bread, crackers, and pastry bought at from 10 to 25 cents per pound. It also contained less protein, and this chiefly in the form of nitrogenous extractive matter with a very small actual nutritive value as compared with that of bread protein.

It should be borne in mind that in many instances the high prices given in the table may be attributed to the fact that the articles were purchased in limited quantities and in packages, factors which would tend to increase the cost. The difference in price of the molasses and sugar cookies is thus explained, since the former were bought in small packages and the latter in bulk. In general it was found that prices for the class of goods purchased were no higher in the White Mountain district than elsewhere.

As regards the nutrients and energy furnished by the different foods, it may be said that the various meats, the sardines and eggs were high in protein, and the crackers, pastry and sugars, high in energy. The fried bacon and deviled ham, cheese, peanut butter, chocolate and malted milk tablets were high in both protein and energy and may be considered concentrated foods. The deviled ham, cheese and peanut butter were also among the least expensive foods purchased.

Availability of nutrients and energy.—Since only that portion of the food which is assimilated by the body can be used for the building of tissue and the yielding of energy, it is upon the amounts of nutrients and energy available for these purposes, rather than the total amounts as shown by analyses, that their value depends. The figures given in Table 20 for energy (fuel value) actually represent the quantities available, but those given for protein, fats and carbohydrates do not. Since, however, the chief function of the fats and carbohydrates is to serve as sources of energy, the proportion which they individually supply signify very little, and their recalculation is therefore not here attempted. To obtain the amounts of available protein, the various food materials have, for convenience, been grouped under ten general classes, namely, meats, fish, eggs, dairy products, breads, pastry, sugars, fruits, nuts, and beverages. The amounts of available protein have then been

computed for each of these classes, by means of factors—the so-called coefficients of availability. These have been derived from the results of actual digestion experiments,* and are given in Table 21 below. The figures show what percentages of the total protein are available for body use.

TABLE 21.

Coefficients of availability of protein of different classes of food materials.

CLASS OF FOOD.													Protein.
													%
Meats,	-	-	-	-	-	-	-	-	-	-	-	-	97
Fish,	-	-	-	-	-	-	-	-	-	-	-	-	97
Eggs,	-	-	-	-	-	-	-	-	-	-	-	-	97
Dairy products,	-	-	-	-	-	-	-	-	-	-	-	-	97
Bread, crackers, etc.,	-	-	-	-	-	-	-	-	-	-	-	-	85
Pastry, etc.,	-	-	-	-	-	-	-	-	-	-	-	-	85
Sugars, etc.,	-	-	-	-	-	-	-	-	-	-	-	-	—
Fruits,	-	-	-	-	-	-	-	-	-	-	-	-	85
Nuts,	-	-	-	-	-	-	-	-	-	-	-	-	80
Beverages,	-	-	-	-	-	-	-	-	-	-	-	-	97

Weights of the subjects.—The weights of both subjects were taken on ordinary platform scales weighing to pounds and ounces, at 5 P. M. of the afternoon preceding the trip and at the same hour of the day of the return. During the trip the only opportunity afforded was met with on the fifth day when the weights were secured at 11 A. M. The figures thus obtained are given in the sections dealing with the separate studies.

Number and scope of the studies.—Two studies were completed, one with each subject. Each began with supper of the first day and ended with dinner of the eighth day. The total number of regular meals was twenty-one, corresponding to seven full days. In addition, considerable quantities of food were consumed from time to time between meals.

In the sections following, the data for each study are presented in detail. The menu showing the kind and amount of food consumed at each meal is first given. It will be noted that in addition to the three regular meals other items frequently

* Storrs Experiment Station Report 1899, p. 73.

appear under the heading "lunch." These refer to materials, such as berries, birch beer, etc., consumed as already explained from time to time during the day, and are grouped in this way solely for convenience.

Following the menus is a table showing the amounts consumed of each food material for the entire period, the quantities of total and available nutrients and energy obtained from each class of foods, and the cost.

DIETARY STUDY NO. 459.

The subject of this study was C. H. C., employed as a college instructor about nine months in the year. Previous to the trip, he had spent about two months of his vacation playing tennis, walking, etc., the total daily exercise estimated as corresponding to a walk of from six to eight miles per day. He was of athletic build, weighing normally with clothing about 175 pounds, was six feet two inches tall, and at the time of the study was in perfect health. His weight as taken on the day preceding the trip was 174 pounds, on the fifth day, 165 pounds, and on the final day, 166.5 pounds, a net loss of 7.5 pounds during the trip.

MENU.

August 7. Supper: Egg sandwiches (whole wheat bread, 150 grams; eggs 78 grams); milk, 363 grams; chocolate.*

August 8. Breakfast: Beef sandwiches (whole wheat bread, 100 grams; beef, 70 grams); sultanas, 34 grams; chocolate;* malted milk tablets, 2 grams.

Dinner: Beef sandwiches (whole wheat bread, 150 grams; beef, 105 grams); sultanas, 45 grams.

Lunch: Lime drops, 43 grams; malted milk tablets, 1 gram.

Supper: Beef sandwiches (whole wheat bread, 50 grams; white bread, 72 grams; beef, 65 grams); sultanas, 11 grams; chocolate;* malted milk tablets, 5 grams.

August 9. Breakfast: Egg sandwiches (white bread, 72 grams; eggs, 34 grams); eggs, 52 grams; cup cakes, 50 grams; doughnuts, 38 grams.

Lunch: Lime drops, 65 grams; birch beer, 227 grams; chocolate, 16 grams; malted milk tablets, 33 grams.

Dinner: Egg sandwiches (white bread, 54 grams; eggs, 26 grams); cheese, 19 grams; sponge cake, 53 grams.

Supper: Canned tongue, 110 grams; cheese crackers, 48 grams; chocolate, 17 grams; malted milk tablets, 3 grams.

August 10. Breakfast: Canned tongue, 101 grams; cheese crackers, 50 grams; chocolate, 16 grams.

* A cake of chocolate weighing 110 grams was consumed prior to lunch August 9.

Lunch: Milk, 227 grams; gum drops, 30 grams; raspberries, 37 grams; birch beer, 908 grams.

Dinner: Butter crackers, 65 grams; cheese crackers, 14 grams; crispanola, 65 grams; bananas, 160 grams; peanut butter, 37 grams; root beer, 227 grams.

Supper: Canned chicken, 64 grams; butter crackers, 65 grams; crispanola, 31 grams; molasses cookies, 29 grams; maple sugar, 30 grams; peanut butter, 17 grams.

August 11. Breakfast: Butter crackers, 43 grams; molasses cookies, 34 grams; bananas, 104 grams; peanut butter, 28 grams; chocolate 16 grams.

Lunch: Huckleberries, 4 grams; birch beer, 681 grams.

Dinner: Butter crackers, 14 grams; saltines, 53 grams; molasses cookies, 14 grams; sultanas, 34 grams; maple sugar, 23 grams; huckleberries, 9 grams; peanut butter, 60 grams.

Supper: Deviled ham, 78 grams; butter crackers, 108 grams; saltines, 30 grams; sultanas, 67 grams; maple sugar, 76 grams.

August 12. Breakfast: Fried bacon, 21 grams; deviled ham, 16 grams; butter crackers, 85 grams; sultanas, 58 grams; maple sugar, 55 grams.

Lunch: Huckleberries, 32 grams; raspberries, 138 grams; birch beer, 454 grams; chocolate, 8 grams.

Dinner: Sausages, 105 grams; cheese, 18 grams; butter crackers, 5 grams; saltines, 68 grams; maple sugar, 89 grams.

Supper: Deviled ham sandwiches (white bread, 127 grams; deviled ham, 60 grams); eggs, 54 grams; sugar cookies, 38 grams; cup cakes, 67 grams; maple sugar, 65 grams; huckleberries, 34 grams; chocolate 16 grams.

August 13. Breakfast: Beef extract, 5 grams; fried bacon, 18 grams; deviled ham sandwiches (white bread, 101 grams; deviled ham, 45 grams); cheese, 12 grams; saltines, 15 grams; gum drops, 53 grams; maple sugar, 40 grams.

Lunch: Milk, 227 grams; huckleberries, 66 grams; raspberries, 12 grams; root beer, 227 grams; chocolate, 20 grams.

Dinner: Sardines, 108 grams; milk, 227 grams; white bread, 282 grams; saltines, 16 grams; sugar cookies, 34 grams; raisins, 50 grams.

Supper: White bread, 94 grams; cup cakes, 28 grams; sultanas, 99 grams, raisins, 91 grams.

August 14. Breakfast: Beef extract, 13 grams; sausage, 50 grams; eggs, 31 grams; white bread, 221 grams; sultanas, 34 grams, raisins, 43 grams; root beer, 227 grams.

Dinner: Sultanas; 63 grams; raisins, 71 grams; chocolate, 48 grams.

TABLE 22.

Kind, amount and cost of food eaten, and amounts of total nutrients and energy, and available protein and energy supplied in dietary study No. 459.

KIND, AMOUNT AND COST OF DIFFERENT FOOD MATERIALS.	Cost.	AMOUNTS OF TOTAL NUTRIENTS AND ENERGY.				AMOUNTS AVAILABLE.	
		Protein.	Fat.	Carbo-hydrates.	Energy.†	Protein.	Energy.
ANIMAL FOOD.	\$	Gms.	Gms.	Gms.	Cal.	Gms.	Cals.
Beef, sandwich meat, 240 gms., 11 c.; tongue, 211 gms., 12 c.; beef, extract, 18 gms., 9 c.; bacon, fried, 39 gms., 9 c.; ham, deviled, 199 gms., 15 c.; sausage, 155 gms., 11 c.; chicken, 64 gms., 14 c. Total meats, -	.81	195.2	213.9	—	—	189.3	2796
Sardines, 108 gms., - - -	.15	24.8	21.3	—	—	24.1	300
Eggs, boiled, 269 gms., - -	.13	35.5	32.3	—	—	34.4	457
Cheese, 82 gms., 6 c.; milk, 1044 gms., 9 c. Total dairy products, -	.15	55.7	69.4	54.2	—	54.0	1105
Total animal food, - - -	1.24	311.2	336.9	54.2	—	301.8	4658
VEGETABLE FOOD.							
Bread, white, 1023 gms., 23 c.; bread, whole wheat, 450 gms., 10 c.; crackers, butter, 385 gms., 21 c.; crackers, cheese filled, 112 gms., 11 c.; saltines, 182 gms., 13 c.; crispanola, 96 gms., 7 c. Total bread, crackers, etc., -	.85	214.3	100.9	1323.1	—	182.2	7222
Cup cakes, 145 gms., 3 c.; cake, sponge, 53 gms., 2 c.; cookies, molasses, 77 gms., 4 c.; cookies, sugar, 72 gms., 2 c.; doughnuts, 38 gms., 1 c.; sultanas, 445 gms., 22 c. Total pastry, etc., -	.34	51.6	73.7	581.4	—	43.9	3226
Candy, 191 gms., 17 c.; sugar, maple, 378 gms., 17 c. Total sugars, etc., - - -	.34	—	—	496.4	—	—	2032
Bananas, 264 gms., 7 c.; huckleberries, 145 gms., 0*; raisins, seeded, 255 gms., 6 c.; raspberries, red, 187 gms., 0.* Total fruits and berries, - - -	.13	12.8	10.9	299.9	—	10.9	1385
Peanut butter, 142 gms., 10 c., -	.10	41.6	66.0	24.3	—	33.3	883
Beer, birch and root, 2951 gms., 50 c.; chocolate, 267 gms., 60 c.; malted milk tablets, 44 gms., 34 c. Total beverages, - -	1.44	31.0	84.8	509.0	—	30.1	2919
Total vegetable food, - - -	3.20	351.3	336.3	3234.1	—	300.4	17667
Total food, - - -	4.44	662.5	673.2	3288.3	—	602.2	22325
Average per day, - - -	.63	94.6	96.2	469.8	—	86.0	3189

* Not purchased.

† Not computed.

DIETARY STUDY NO. 460.

The subject of this study was H. L. K., 24 years of age, employed at editorial work. He took a small amount of muscular exercise mostly in walking and tennis, the total comprising a probable maximum equivalent of a five mile walk daily. His general health had been good to within a month of the experiment when a slight nervous trouble had resulted in less exercise than usual. A week of his vacation had elapsed before the trip was undertaken, and at that time he felt nearly as well as usual, though his weight, with clothing normally 135 pounds, had fallen to 124.5 pounds on the day preceding the trip. On the fifth day, a further drop to 119.75 pounds was noted. The final day showed no further change, making a net loss of 4.75 pounds during the trip.

MENU.

August 7. Supper: Egg sandwiches (whole wheat bread, 50 grams; eggs, 26 grams); milk, 545 grams; chocolate.*

August 8. Breakfast: Beef sandwiches (whole wheat bread, 50 grams; beef, 35 grams); sultanas, 22 grams; chocolate;* malted milk tablets, 2 grams.

Lunch: Lime drops, 8 grams; malted milk tablets, 3 grams.

Dinner: Beef sandwiches (whole wheat bread, 100 grams; beef, 70 grams); sultanas, 23 grams.

Supper: Beef sandwiches (white bread, 72 grams; beef, 30 grams); cheese, 36 grams; sultanas, 11 grams; chocolate;* malted milk tablets, 5 grams.

August 9. Breakfast: Egg sandwiches (white bread, 36 grams; eggs, 17 grams); eggs, 58 grams; cheese, 34 grams; doughnuts, 37 grams.

Lunch: Lime drops, 14 grams; malted milk tablets, 8 grams.

Dinner: Egg sandwiches (white bread, 54 grams; eggs, 26 grams); cheese, 19 grams; chocolate cake, 58 grams.

Supper: Canned tongue, 110 grams; cheese crackers, 11 grams; chocolate, 17 grams; malted milk tablets, 3 grams.

August 10. Breakfast: Canned tongue, 101 grams; cheese crackers, 20 grams; chocolate, 6 grams.

Lunch: Milk, 227 grams; huckleberries, 18 grams; raspberries, 33 grams; birch beer, 908 grams.

* A cake of chocolate weighing 110 grams was consumed prior to lunch August 9.

Dinner: Cheese crackers, 17 grams; butter crackers, 43 grams; bananas, 94 grams; peanut butter, 17 grams.

Supper: Canned chicken, 78 grams; butter crackers, 21 grams; crispanola, 35 grams; molasses cookies, 14 grams; maple sugar, 28 grams.

August 11. Breakfast: Butter crackers, 43 grams; bananas, 114 grams; peanut butter, 26 grams; chocolate, 16 grams.

Lunch: Huckleberries, 5 grams; birch beer, 681 grams.

Dinner: Saltines, 23 grams; molasses cookies, 10 grams; sultanas, 34 grams; maple sugar, 21 grams; huckleberries, 4 grams; peanut butter, 35 grams.

Supper: Deviled ham, 82 grams; saltines, 38 grams; sultanas, 22 grams; maple sugar, 23 grams.

August 12. Breakfast: Fried bacon, 13 grams; deviled ham, 15 grams; butter crackers, 35 grams; sultanas, 22 grams; maple sugar, 36 grams.

Lunch: Huckleberries, 20 grams; raspberries, 102 grams; birch beer, 454 grams.

Dinner: Sausage, 105 grams; cheese, 21 grams; butter crackers, 5 grams; saltines, 30 grams.

Supper: Deviled ham sandwiches (white bread, 89 grams; deviled ham, 45 grams); eggs, 52 grams; maple sugar, 31 grams.

August 13. Breakfast: Beef extract, 5 grams; fried bacon, 12 grams; eggs, 42 grams; cheese, 11 grams; saltines, 15 grams; bananas, 101 grams; raspberries, 10 grams.

Lunch: Milk, 227 grams; huckleberries, 50 grams; raspberries, 28 grams.

Dinner: Milk, 227 grams; bread, 82 grams; sugar cookies, 39 grams; raisins, 39 grams.

Supper: Bread, 94 grams; sugar cookies, 26 grams; raisins, 66 grams.

August 14. Breakfast: Beef extract, 13 grams; sausage, 17 grams; bread, 117 grams; raisins, 34 grams.

Dinner: Butter crackers, 25 grams; raisins, 64 grams; chocolate, 48 grams.

TABLE 23.

Kind, amount and cost of food eaten, and amounts of total nutrients and energy, and available protein and energy supplied in dietary study No. 460.

KIND, AMOUNT AND COST OF DIFFERENT FOOD MATERIALS.	Cost.	AMOUNTS OF TOTAL NUTRIENTS AND ENERGY.				AMOUNTS AVAILABLE.	
		Protein.	Fat.	Carbo-hydrates.	Energy†	Protein.	Energy.
ANIMAL FOOD.	\$	Gms.	Gms.	Gms.	Cal.	Gms.	Cals.
Beef, sandwich meat, 135 gms., 6 c.; tongue, 211 gms., 12 c.; beef, extract, 18 gms., 9 c.; bacon, fried, 25 gms., 6 c.; ham, deviled, 142 gms., 10 c.; sausage, 122 gms., 9 c.; chicken, 78 gms., 16 c. Total meats, - - -	.68	149.4	174.4	—	—	144.9	2240
Eggs, boiled, 204 gms., - -	.10	26.9	24.5	—	—	26.1	347
Cheese, 121 gms., 9 c.; milk, 1226 gms., 11 c. Total dairy products, - - -	.20	71.8	89.8	64.2	—	69.6	1403
Total animal food, - - -	.98	248.1	288.7	64.2	—	240.6	3990
VEGETABLE FOOD.							
Bread, white, 544 gms., 12 c.; bread, whole wheat, 200 gms., 4 c.; crackers, butter, 172 gms., 9 c.; crackers, cheese filled, 48 gms., 5 c.; saltines, 106 gms., 7 c.; crispanola, 35 gms., 3 c. Total bread, crackers, etc., -	.40	105.0	49.0	646.1	—	89.3	3527
Cake, chocolate layer, 58 gms., 2 c.; cookies, molasses, 24 gms., 1 c.; cookies, sugar, 65 gms., 2 c.; doughnuts, 37 gms., 1 c.; sultanas, 134 gms., 7 c. Total pastry, etc., - - -	.13	20.4	31.1	217.7	—	17.3	1251
Candy, 22 gms., 2 c.; sugar, maple, 139 gms., 6 c. Total sugars, etc., - - -	.08	—	—	136.2	—	—	557
Bananas, 309 gms., 8 c.; huckleberries, 97 gms., 0;* raisins, seeded, 203 gms., 4 c.; raspberries, red, 173 gms., 0.* Total fruits and berries, - - -	.12	11.6	9.2	260.4	—	9.9	1202
Peanut butter, 78 gms., 5 c., -	.05	22.9	36.3	13.3	—	18.3	485
Beer, birch, 2043 gms., 35 c.; chocolate, 197 gms., 45 c.; malted milk tablets, 21 gms., 16 c. Total beverages, - - -	.96	21.1	62.3	351.8	—	20.5	2049
Total vegetable food, - - -	1.74	181.0	187.9	1625.5	—	155.3	9071
Total food, - - -	2.72	429.1	476.6	1689.7	—	395.9	13061
Average per day, - - -	.39	61.3	68.1	241.4	—	56.6	1866

* Not purchased.

† Not computed.

RESULTS OF THE DIETARY STUDIES.

From Tables 22 and 23 above, a comparative estimate of the dietaries of the two subjects may be obtained. It will be noted that in study No. 459, C. H. C. consumed daily an average of 86.0 grams of protein and 3189 calories of energy in forms available to the body. The protein was obtained in about equal portions from the animal and vegetable food, the chief sources being the meats, bread and crackers. These foods, together with the pastry and beverages, likewise furnished the bulk of the energy, four-fifths of it, however, being of vegetable origin. The cost was 63 cents per day, of which 28 per cent. was for animal and 72 per cent. for vegetable food. One-third of the total cost was expended for beverages, though these furnished but 5 per cent. of the available protein and 13 per cent. of the available energy.

The daily quantities of available protein and energy consumed by H. L. K., in study No. 460 were 56.6 grams and 1866 calories respectively. Larger percentages came from animal food than in the preceding study, 60 per cent. of the protein and 30 per cent. of the energy being thus obtained, as compared with 50 and 20 per cent. in study No. 459. This difference may be attributed very largely to circumstances already explained. The amount of meats on hand was usually limited and it was the custom to make a nearly equal division, while the vegetable food was used to make up the remainder of the meal according to the dictates of appetite. The cost in this dietary was 39 cents per day, of which 25 per cent. was for meats, 15 per cent. for bread and crackers and 35 per cent. for beverages.

The total cost of the diet in the case of H. L. K. was two-thirds of that of C. H. C. This is partly due to slight differences in their respective diets, though the chief explanation is to be sought in the much smaller food consumption of the former.

Errors in the selection of food materials.—As regards the selection of food materials, no serious errors appear to have been made, though a much larger return was obtained from some foods than from others and had economy been sought some money could doubtless have been saved by replacing some of

the foods by similar cheaper materials. Thus, the money expended for the canned chicken and fried bacon would have bought much larger quantities of the deviled ham or canned tongue. The cheese and peanut butter were economical foods under the circumstances and might have been used more largely. The most expensive materials purchased were the beverages. The malted milk tablets in particular yielded a very small amount of nutrients in proportion to their cost, and it is highly probable that a package of cereal coffee or some similar article could have been substituted to good advantage. The large expenditure for the beef extract, the birch and root beer, and to a lesser degree, of the chocolate, must be justified because of considerations other than nutritive value. The expenditures for the more expensive meats and crackers are likewise chiefly warranted because of the obvious desirability of securing variety in the diet and of providing food which was relished by the subjects. The amount expended, \$3.08 per man for the entire week, is no larger than would be expected under the conditions.

Adequacy of the diet.—The true criterion of the value of a diet is manifestly not its cost but its adequacy for the body needs. Reference has already been made to the marked disparity in the food consumption of the two subjects. This is in part accounted for by the fact that C. H. C. was a man eight inches taller and 50 pounds heavier than his companion. That this is not a complete explanation, however, is shown by Table 24 which follows. In this table are summarized the total daily quantities of available protein and energy obtained by each subject and the amounts thus furnished per kilo of their initial body weights. For purposes of further comparison, similar data from other studies and the commonly accepted dietary standards for men of sedentary occupation and of light to moderate muscular work are also included.

Per kilo of body weight, the daily available protein obtained by C. H. C. was 1.1 grams and that by H. L. K. 1.0 gram, while the available energy was respectively 40 and 33 calories. The reason for this difference is not entirely clear, as the conditions were in most respects the same for both subjects. The weighing of the food and recording of data, however, fell

TABLE 24.

Amounts of available Protein and Energy per day and per kilo of body weight.

SUBJECT.	Protein.	Energy.	Body Weight.	PER KILO OF BODY WEIGHT.	
				Protein.	Energy.
	Gms.	Cals.	Kilos.	Gms.	Cals.
C. H. C., - - - - -	86.0	3189	79.1	1.1	40
H. L. K., - - - - -	56.6	1866	56.4	1.0	33
Average of ten Harvard students, ¹ - - -	78.1	2720	59.8	1.3	45
Professional pedestrian, Weston, ² - - -	196.0	4065	60.0	3.3	68
Professional pedestrian, Schmell, ³ - - -	164.5	—	65.8	2.5	—
Average of 7 Russian students at rest, ⁴ -	100.0	—	—	—	—
Average of 7 Russian students walking, ⁴ -	107.0	—	—	—	—
Canoeing party in Maine, ⁵ - - - - -	158.0*	5145*	—	—	—
<i>Dietary Standards.</i>					
Man with sedentary occupation, - - -	92.0	2700	68.0	1.4	40
Man with light to moderate muscular work,	103.0	3050	68.0	1.5	45

1 U. S. Dept. Agr., Office of Experiment Stations Bul. 152, p. 56.

2 Conn. (Storrs) Sta. Report, 1902-3, p. 135.

3 U. S. Dept. Agr., Office of Experiment Stations Bul. 45, p. 119; Flint, Relation of Urea to Exercise, p. 19.

4 U. S. Dept. Agr., Office of Experiment Stations Bul. 45, p. 121.

5 Conn. (Storrs) Sta. Report, 1902-3, p. 135.

* Food purchased.

wholly on H. L. K. As this work was of necessity done almost entirely at meal times, he frequently ate more hastily than was his usual habit. This may have tended to decrease his food consumption to a certain extent, and the writer is inclined to believe such was the case.

Comparison with the other data included in Table 24 indicates that the food consumption of both subjects was small. Per kilo of body weight, the amounts of protein and energy obtained by the two were, in fact, lower than even the figures obtained with the Harvard students with little exercise, or the amounts called for by the commonly accepted standards for men with sedentary occupations.

That the food consumption was adequate is doubtful. The record of body weights as given on pages 152 and 155 shows a loss in weight in the first five days of 9 pounds for C. H. C.

and of 4.75 pounds for H. L. K. For the remainder of the study there was a gain of 1.5 pounds with C. H. C. or a net loss of 7.5 pounds for the whole period, and no further change in the case of H. L. K. To be sure, it is well known that body weight alone is by no means a reliable indicator of actual body conditions. Loss in weight may be of little significance if due to increased elimination of water, and an apparent gain may be a real loss, as in the replacement of fat by water. The loss of weight at the start is not surprising since the suddenly increased muscular exertion would naturally draw upon the reserve materials for the body for a time regardless of the diet. At the same time, so large a loss tends to confirm the belief that the diet was not large enough. A study of the menus shows that more food was eaten on the last days of the trip. This also would indicate that the body has been insufficiently supplied. Further evidence is found in the fact, mentioned beyond, that both subjects recovered normal weight in a few days after the trip had ended.

As no means were available for estimating the outgo of nitrogen, no determination of the gain or loss of this element was possible, but there is further evidence that in the case of H. L. K. the amount of energy supplied was insufficient. A few months before, several experiments had been made with this subject in which it was shown by means of the respiration calorimeter that his normal heat production, while sitting as quietly as possible, was about 90 calories per hour. Long series of similar experiments with other subjects show that the heat elimination during sleep was at least 50 calories per hour. Assuming that nine hours were spent in sleep the heat production per day of this subject when at rest becomes $9 \times 50 + 15 \times 90 = 450 + 1350 = 1800$ calories.

Using Haughton's* formulas for the work done in walking both on horizontal and inclined planes, a rough estimate, which however, is a minimum figure, of 963,225 foot pounds per day may be obtained. This divided by 3,088, the mechanical equivalent of 1 calorie, gives as the consequent heat production, 312 calories, making a minimum of 2,112 calories actually required as compared with 1,866 furnished by the food.

* Principles of Animal Mechanics, pp. 57, 58.

Less complete data are at hand in the case of C. H. C., but from what is known of the heat elimination of other subjects of his weight, here also there must have been a considerable deficit.

While no definite information can be obtained as to the food consumption of either subject previous to the experiment, it is certain that their normal diet with only sedentary work was quite as large as when walking twenty miles a day. This seems rather surprising. Zasietsky,* however, in his experiments with the Russian students summarized in Table 24 above, obtained similar results. In his experiments seven students after two or three days of absolute rest (lying down) walked for several days from 9 A. M. to 9 P. M. with short intervals of rest. No marked influence of exercise upon the amount of food consumed was noted, though he attempts no explanation for this. In the present investigation it seems most probable that the necessity of economizing in bulk and weight of the food carried produced a tendency to economize unconsciously in the food consumed.

On the return from the journey both subjects resumed their ordinary diets and their usual daily occupations. Both immediately noted unusually good appetites and while the food was not weighed the consumption unquestionably increased. H. L. K. regained his initial weight in five days and C. H. C. in four days. At the end of a week the latter reported further slight gains. Aside from occasional discomfort due to climatic conditions, no ill effects other than loss in weight were noticed at any time during the journey. Both subjects felt better when they returned than when they started, and their subsequent physical condition has revealed no detrimental results traceable to the trip.

SUMMARY.

In these studies, two young men of sedentary habit walked without previous training an average distance of twenty miles per day for seven consecutive days, each carrying about twenty-five pounds of luggage. Notwithstanding the unwonted physical exertion, their food consumption did not increase, though

* U. S. Dept. Agr. Office of Experiment Stations Bul. 45, pp. 121 and 131.

the diet furnished considerably less protein and energy than are called for by the commonly accepted dietary standards for men at light to moderate muscular work. No positive ill effects were noted, except a loss in weight of about five pounds, and this was regained in less than a week after the return from the journey.

The studies may be considered of interest as an indication of the nutritive value of the food materials available to the pedestrian carrying his daily food supply. The foods selected were on the whole well adapted to the conditions, though it is a question whether some of the less concentrated foods might not have been more largely included to advantage. In the attempt to reduce bulk and weight there was apparently a tendency to restrict unconsciously the food consumption as well, and perhaps to an undue extent. It is not probable that the amounts eaten were adequate for the body needs particularly as regards energy. The condition was therefore one of partial inanition, and so limited a diet could hardly have continued for any considerable period without serious injury. The studies well illustrate how in case of need the reserve forces of the body may be drawn upon for a short time without apparent detriment, as well as the necessity of continuing investigations of this nature for long periods before drawing definite conclusions.

STUDIES OF MARKET MILK.

BY W. A. STOCKING, JR.

The milk annually consumed in this country in its natural form is estimated to have a wholesale value of something over two millions of dollars. The enormous amount of milk which is represented by this money value is used as human food, and a greater or less part finds its way into practically every household in this country. It is easy to see, then, why there has been during the past few years such a general sentiment in favor of a better quality of milk for use in its natural form. This growing sentiment can be seen in the daily press, in the results of scientific investigations and in the individual demands of various households.

This desire for a better quality of milk is only one of the avenues through which the public is demanding better protection for its health. Pure food laws are no longer the exception and at present almost every article designed for human consumption is more or less thoroughly controlled by law and comes more or less completely under legal inspection. All of this is in perfect harmony with the increasing sanitary and scientific knowledge which has developed during the past few years. The public agitation in regard to the quality of the milk delivered to the consumer has not developed by itself but simply as one phase of the general demand for pure foods. Many milk consumers, especially in the cities, have come to realize that the ordinary milk which they are able to purchase in the market is not always what it should be from a sanitary standpoint and are demanding an article which they can safely use as food. As a result of this condition there is at the present time a limited amount of milk put upon the market which is produced under conditions much more sanitary than those under which the ordinary milk is produced. This means an increase in the cost of production and this grade of milk is usually sold

at a price much in advance of that asked for the ordinary milk. Milk produced under these conditions is sold under various names, such as "certified milk," "sanitary milk," and "clinical milk." Such milk is commonly recommended by physicians who from time to time inspect the farms where it is produced and test the milk for its germ content. Such milk commonly sells for a price so much higher than the ordinary milk that most people feel that they cannot afford to use it except where recommended by physicians for specific cases for the use of invalids or for infants. At the present time most of our states and cities have fairly satisfactory laws in regard to the chemical composition of milk sold within their territories and these laws are fairly well enforced by the health boards and milk inspectors. This insures to the consumer a reasonably good quality of milk so far as its chemical composition is concerned and the consumer need have but little fear of getting milk which does not come up to the local requirements so far as fat and total solids are concerned. These same local authorities also very carefully guard the consumer against the use of chemical preservatives in market milk within their jurisdiction. There may be, and frequently is, but little difference so far as chemical composition is concerned between the ordinary milk supply and that sold under the name of "sanitary" or "certified" milk. Both may be rich in milk fat and in solids and be free from any chemical preservatives, yet one may be a perfectly wholesome food while the other is decidedly unwholesome if not positively poisonous. The principal difference between these two grades lies in the sanitary conditions under which the milk has been produced and handled.

Bacteria content of market milk.—With the development of the science of bacteriology it has become possible to study the sanitary condition of the milk which is being daily consumed as human food. The health boards and other authorities are at present making a determined effort to ascertain the real condition of the milk which is delivered in our larger cities and in many instances the conditions brought to light by these examinations are appalling. Park* in New York found that "during the coldest winter weather the milk in New York

* The Bacterial Content of City Milk. H. W. Park, Science, Vol. 13, 1901, p. 322.

City averages about 250,000 bacteria per cubic centimeter. During cool weather about 2,000,000 and during hot weather about 5,000,000."

Slack* found that out of 2,394 samples of Boston milk, 42 per cent. showed a germ content of less than 100,000 bacteria per cubic centimeter; 29.75 per cent. was between 100,000 and 500,000; 9.75 per cent. between 500,000 and 1,000,000; 12.75 per cent. between 1,000,000 and 5,000,000; and 5 per cent. above 5,000,000. These counts were made during June, July, August, and September. The results of these tests show that 71.75 per cent. of all the samples taken contained a germ content below the Boston legal limit of 500,000 bacteria per cubic centimeter, while 27.50 per cent. were above this limit. These figures represented the milk as it reached the city of Boston.

Conn† found by a study of the milk delivered in the city of Middletown that the germ content of twenty-seven samples taken from different milkmen showed an average of 266,400 bacteria per cubic centimeter. The lowest number found in any sample was 8,100 and the highest 2,973,800.

Hellens‡ found by a study of market milk sold in Helsingfors that the milk contained "during the summer from 20,000 to 34,300,000 bacteria per cubic centimeter, the average being 4,745,000, while in the winter the bacteria content ranged from 70,000 to 18,630,000, and averaged 2,111,000. About 60 per cent. of the summer samples contained from 1,000,000 bacteria per cubic centimeter against 35 per cent. in the winter samples."

In a series of studies|| of the market milk sold in the city of Guelph, Harrison found that the germ content ranged from 121,000 to 1,200,000 per cubic centimeter. At the same time the milk produced at the College dairy ranged from 8,000 to 18,000 per cubic centimeter.

Out of 291 samples§ of milk purchased in the open market of Chicago during April, May, and June, 1904, Jordan found

* Am. Journal of Public Hygiene, Nov., 1904.

† Report of Storrs Experiment Station, 1902-3, p. 76.

‡ O. V. Hellens, Nord. Mejeri Tidn., 14, 1899.

|| Ontario Agricultural and Experiment Farm Report, 1896.

§ Health and Sanitation Committee of the Civic Federation of Chicago, 1904.

that "the average number of bacteria per cubic centimeter exceeded 9,000,000 in April, 10,000,000 in May, and 18,000,000 in June. The range in the different samples was from 10,000 to 74,000,000 per cubic centimeter. Only 1.4 per cent. of the total number of samples showed less than 50,000 bacteria per cubic centimeter."

Individual lots of milk frequently run much higher in bacteria than any of the figures given here. The number of bacteria per cubic centimeter is an indication of the care under which the milk has been produced and handled. There is, on the other hand, considerable milk sold especially in the smaller cities which has a much smaller germ content than the figures given.

De Schweinitz* tested thirty-two samples of milk taken from fifteen different dairy wagons as delivered in the city of Washington, D. C. Of these thirty-two samples one showed only about 2,500 bacteria per cubic centimeter, one 4,000, five others between 10,000 and 15,000, six between 30,000 and 50,000, and the remainder more than 50,000 per cubic centimeter, in several instances running above 115,000 bacteria per cubic centimeter.

When we compare these large numbers of bacteria which are found in milk at the time it is delivered to the consumers with the small numbers existing in the milk as it leaves the udder of the healthy cow (from a dozen or two to a few hundred per cubic centimeter) the contamination and improper treatment which takes place in the production and subsequent handling of the milk is apparent.

Bacterial content of sanitary milk.—In contrast to the numbers found in ordinary market milk it is interesting to note the numbers of bacteria found in the so-called "sanitary milk" as it reaches the consumer. De Schweinitz found that "sanitary milk" as delivered in Washington contained a bacterial content varying from 200 to 5,000 bacteria per cubic centimeter. Out of 135 samples examined only eleven showed a bacterial content of over 5,000 per cubic centimeter. As a result of his investigation De Schweinitz makes the following statement:

* A Report upon Examination of Milk. E. A. De Schweinitz, Annual Report of Bureau of Animal Industry, 1899, p. 148.

Week ending September 4:

Barn B,	-	-	-	-	-	-	-	-	-	21,000
Barn C,	-	-	-	-	-	-	-	-	-	18,400
Barn D,	-	-	-	-	-	-	-	-	-	4,100
Barn E,	-	-	-	-	-	-	-	-	-	1,500
Barn F,	-	-	-	-	-	-	-	-	-	2,100

Week ending September 11:

Herd sample,	-	-	-	-	-	-	-	-	-	6,100
Barn B,	-	-	-	-	-	-	-	-	-	13,000
Barn C,	-	-	-	-	-	-	-	-	-	16,000
Barn D,	-	-	-	-	-	-	-	-	-	11,900
Barn E,	-	-	-	-	-	-	-	-	-	17,600
Barn F,	-	-	-	-	-	-	-	-	-	12,900

It is stated that these numbers run considerably higher than the normal because of the fact that the barns were being filled with hay thus causing considerable dust during this period. This would seem to be the case in view of the fact that a week's record during the winter showed the following results:

Herd sample,	-	-	-	-	-	-	-	-	-	3,150
Barn B,	-	-	-	-	-	-	-	-	-	950
Barn C,	-	-	-	-	-	-	-	-	-	300
Barn E,	-	-	-	-	-	-	-	-	-	1,500
Barn F,	-	-	-	-	-	-	-	-	-	1,200

These tests were made by the New York Medical Society after the milk reached the city.

The following week's record shows the germ content of the milk produced at Vine Hill farm:

June 20,	-	-	-	-	-	-	-	-	-	1,140
June 21,	-	-	-	-	-	-	-	-	-	4,320
June 22,	-	-	-	-	-	-	-	-	-	200
June 23,	-	-	-	-	-	-	-	-	-	2,940
June 24,	-	-	-	-	-	-	-	-	-	630
June 25,	-	-	-	-	-	-	-	-	-	2,340
June 26,	-	-	-	-	-	-	-	-	-	2,640

The following figures illustrate the germ content of the milk produced by the Purity Milk Co. being plated for bacteria at the time it was delivered to the consumer when from eighteen to twenty-four hours old. The figures here given represent ten consecutive counts taken at random from a year's record.

The first column represents the milk from their new improved stables while the second column shows the results obtained in ordinary old barns which were cleaned up and whitewashed and where intelligent care was used in the production and handling of the milk.

	New Barn.	Old Barn.
December 4, - - - - -	200	410
December 5, - - - - -	170	385
December 8, - - - - -	247	463
December 10, - - - - -	397	506
December 11, - - - - -	150	8,565
December 14, - - - - -	165	974
December 16, - - - - -	460	1,237
December 19, - - - - -	350	833
December 22, - - - - -	447	893
December 29, - - - - -	145	865
Average, - - - - -	273	1,513

The comparatively low numbers of bacteria found in these "sanitary" milks at the time of delivery shows beyond a question that it is possible to supply to the consumer milk which carries a relatively low bacterial content. The question is at once forced upon us as to the cause of the great difference in numbers between "sanitary" and ordinary milk and at what point in the production or handling the greater contamination takes place. Most of the bacterial studies made of market milk have been made in the large cities after the milk has been shipped long distances and is of considerable age. Comparatively little study has been made of the germ content of ordinary milk as produced by the farmer and delivered to the local consumer or the shipping station for transportation to the larger cities. In order to improve the sanitary quality of our market milk it is necessary to know the points at which the contamination and improper care take place. Believing that it is necessary to have more data concerning the condition of the milk as it leaves the producer in order to locate the essential points of contamination this Station has for the past two years spent considerable effort in determining the actual bacterial and sanitary condition of the milk as produced and delivered by individual dairymen.

The results given in this paper were obtained from samples taken from the milk of individual producers as it was delivered to the shipping station from which it was sent to Providence, R. I.

METHOD OF THESE EXPERIMENTS.

As already stated the milk used in these experiments was obtained from the individual producers as it was delivered to the shipping station each morning. This work was made possible through the kindness and coöperation of the Providence Dairy Co. at whose plant the samples were taken. As each man's milk was received at the station his night's and morning's milk was thoroughly mixed and a sample taken. At this time the temperature of the milk was taken and also the lactometer reading which was later used for computing the total solids. A small laboratory for bacteriological work was fitted up in the building and as soon as samples were obtained they were carried to this room where plate cultures were at once made. For this work the culture media used was the milk sugar litmus gelatin which we commonly use for our milk work where a differentiation of species is desired. Three different dilutions were used for each sample of milk, duplicate plates of each dilution being made. The results given, therefore, represent the average from the six plates made. At the beginning of this work it was difficult to use dilutions which would give us the proper number of colonies per plate, but after each man's milk had been plated a few times we were able to settle upon certain dilutions for his milk which gave quite satisfactory results in each case. It was found necessary to use different dilutions for the different men inasmuch as the germ content of the milk of the different producers varied so greatly. After plating the day's samples the plates were brought to the Station laboratory for incubation. Samples of the milk were also brought to the laboratory for determining the butter-fat and the keeping quality. The latter was determined by keeping the samples under uniform conditions until they reached the laboratory when they were placed in a constant temperature of 20° C. and the time of curdling noted. From the samples brought to the laboratory notes were taken on the amount of insoluble dirt contained in the milk. Owing to the amount of work involved in making quantitative dirt

determinations it was impossible to determine the dirt by this method where so many samples were handled each day. An arbitrary scale for determining the dirt was therefore adopted. By this method each sample of milk was marked according to the dirt which was visible in the bottom of the sample bottle after it had stood a certain length of time. The scale used ran from 1 to 7. A sample containing a very slight amount of sediment was marked 1; one containing slightly more was marked 2; still more 3, and so on up the scale, 7 indicating samples containing the greatest amount of dirt. These figures, as will be seen, represent the relative amount of visible dirt which the different samples contained and are valuable simply as a means of comparison. In certain cases centrifugal tests were made to determine the amount of dirt, and in certain others the weight of the dried dirt was determined by the method described in Bulletin No. 25 of this Station, page 10. These results will be given later in connection with certain other data. It was found that the marks given on the basis of the above arbitrary scale compared very closely with the actual amounts of dirt determined by weight. It is believed, therefore, that this method gives a fairly accurate basis for comparison of the dirt which the milk contained.

After the plates had been incubated in the laboratory for six days at 20° C. they were studied and the following determinations made:

1. The total number of bacteria present.
2. The number of acid producing bacteria.
3. The number of rapid liquefying bacteria.
4. The number of slow liquefying bacteria.
5. The species or types comprising the greater part of the organisms present.

After these facts were ascertained the percentage of acid producing bacteria and the percentage of liquefiers taking the two groups together was also determined.

It will be readily understood that in order to give the results of such a line of experiments it will be necessary to use a vast number of figures. In fact it is practically impossible to present the data thus obtained in any other than in tabular form.

While certain parts of the data might be condensed into a smaller number of tables such tables would not bring out the real conditions of the milk which would be shown in the complete tables in the form that they are given in the following pages. One of the special purposes of this investigation is to show the exact condition from day to day of the milk of the different producers so far as the temperature, solids, fat, dirt, and germ content are concerned together with the nature of the bacteria present. It is manifestly impossible to bring out these facts in detail in connection with each man's milk in any other way than by giving the complete data in tabular form. In view of these facts the writer feels justified in presenting in this article the unusually large number of tables. He is, however, aware of the fact that to the average reader figures make dry reading and frequently prevent a man from reading an article which he might otherwise read; but in view of the fact that this report finds its way into the hands of scientific men who want the facts as they are, the complete tables will be given with such explanation as it seems desirable to make. In connection with each table only certain special features will be discussed while the facts which remain more or less constant throughout the series together with certain general conclusions will be left for discussion toward the end of the report.*

In all, the milk of thirty different producers was studied in this investigation and the results of the chemical and bacteriological analyses of the milk of these thirty producers are given in detail in the following pages.

PRODUCERS GROUPED ACCORDING TO GERM CONTENT OF MILK.

It was found that there was a great difference in the numbers of bacteria contained by the milk of the different men and on the basis of the total germ content it will be possible to group somewhat the results of the analyses from the different producers. This will in some measure simplify the discussion. In group 1 are placed all those producers whose milk contained

* In this report only the chemical and bacteriological results of the analyses will be discussed. The conditions surrounding the production and handling of the milk will be reserved for a separate discussion which will be published later. A discussion of the types and species of bacteria found in the milk of the different producers is also reserved for a separate report.

an average of less than 100,000 bacteria per cubic centimeter; group 2 contains those where the bacteria averaged between 100,000 and 500,000 per cubic centimeter; group 3 contains those producers where the bacteria averaged between 500,000 and 1,000,000 per cubic centimeter; group 4 includes the results of those men where the average is between 1,000,000 and 2,000,000 bacteria, while in group 5 are placed all those producers whose average was above 2,000,000 bacteria per cubic centimeter.

Discussion of group 1.—This group contains the results obtained from the milk of those men where the average number of bacteria per cubic centimeter is below 100,000 for the whole series of tests. The milk of but two producers comes within this group.

In Table 25 it will be seen that the lowest number of bacteria which the milk of producer No. 1 contained was 6,830 while the largest number on any day was 106,300 giving an average for the whole series of tests of 61,660 bacteria per cubic centimeter. The percentage of acid organisms varied from 10 per cent. on November 4 to 51 per cent. on December 20, the average percentage being 35.7. While the numbers of bacteria in this man's milk are the lowest of any of the thirty the insoluble dirt ran comparatively high varying from 3 to 6 in the scale adopted with an average of 4.5. This relation between the dirt and the bacteria is an exception to the normal condition. It seems doubtful if milk with that amount of dirt could be held with so low a number of bacteria without the aid of preservatives. This seems especially probable inasmuch as the temperature of the milk was not below the average. The milk was not tested for preservatives and this point cannot be definitely stated. With this one exception the milk which contained relatively low numbers of bacteria showed also relatively small amounts of insoluble dirt.

In Table 26 it will be seen that the lowest number of bacteria found in the milk of producer No. 2 is 6,580 while the highest number is 663,750, the average for the whole series of tests being 81,650. The percentage of acid bacteria varied from 0 on November 1 to 86 on March 7, with an average of

TABLE 25.
Showing Composition of Milk of Producer No. 1.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 23.	51	30.0	4.3	8.50	12.80	—	—	87,080	29,160	33	3,750	2,080	7
October 11.	—	30.5	3.6	8.49	12.09	5	42	166,450	73,120	44	20,620	2,500	14
November 1.	48	33.4	4.0	9.32	13.32	4	61	50,620	10,620	21	0	8,120	16
November 4.	—	—	—	—	—	—	—	—	—	—	—	—	—
December 2.	55	34.3	4.0	9.57	13.57	3	48	94,790	9,790	10	5,410	7,910	14
December 3.	51	32.9	3.6	9.09	12.69	4	88	6,830	2,160	32	0	330	5
December 6.	50	32.7	4.0	9.12	13.12	4	71	46,500	10,080	21	0	1,830	4
December 9.	48	32.4	3.8	9.03	12.83	5	67	84,160	17,000	20	750	6,750	9
December 10.	51	31.8	4.0	8.94	12.94	3	—	27,750	6,160	22	1,410	830	8
December 20.	52	32.5	4.1	9.09	13.19	3	72	72,580	37,250	51	500	6,160	9
December 29.	49	32.5	4.0	9.07	13.07	4	—	33,000	7,580	23	166	750	3
January 3.	46	31.9	4.0	8.67	12.67	5	89	31,870	10,890	34	0	3,540	11
February 24.	42	32.0	4.5	9.04	13.54	6	—	24,910	9,910	40	0	917	4
March 3.	52	32.5	4.2	9.11	13.31	6	—	106,300	39,700	37	3,600	10,700	13
March 14.	54	32.2	4.6	9.20	13.80	6	—	30,410	13,000	46	750	500	4
Average.	50	32.3	4.1	9.02	13.07	4.5	67	61,660	16,740	35.7	2,640	3,780	8.6

TABLE 26.
Showing Composition of Milk of Producer No. 2.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 23,	54	32.3	4.4	9.15	13.55	—	—	60,410	12,080	20	833	2,910	6
September 27,	66	31.8	—	—	—	1	24	663,750	148,750	22	10,000	17,700	4
October 11,	—	33.2	5.0	9.39	14.39	3	42	119,000	46,500	39	5,000	2,500	9
November 1,	48	34.3	5.1	9.78	14.88	2	65	8,330	0	0	0	416	5
November 11,	46	33.1	4.7	9.35	14.05	3	85	6,580	1,410	22	83	166	4
November 15,	49	34.0	5.2	9.68	14.88	2	84	33,200	18,370	55	0	625	5
December 2,	48	33.4	4.8	9.46	14.26	3	88	30,700	8,700	28	83	1,580	2
December 3,	35	33.2	5.2	9.48	14.68	3	81	15,250	3,750	25	83	208	2
December 20,	44	33.5	4.8	9.48	14.28	2	48	8,790	1,910	22	0	542	6
December 29,	44	32.2	4.7	9.13	13.83	2	—	64,700	10,330	16	1,160	30,200	48
January 3,	50	32.2	5.0	9.44	14.44	2	89	21,500	8,500	40	0	416	2
February 24,	48	33.4	5.1	9.51	14.61	1	—	18,500	14,080	76	83	1,200	7
March 7,	49	32.5	4.7	9.21	13.91	1	—	76,850	66,000	86	1,050	2,050	4
March 21,	45	33.0	4.8	9.35	14.15	1	—	15,580	4,540	29	416	1,200	11
Average,	48	33.0	4.9	9.42	14.31	2	67	81,850	24,640	31.3	1,340	4,410	8

34.3 per cent. The stable where this milk was produced was probably the least expensive in structure of any of the thirty barns studied, the stable being built simply as a lean-to on the end of the hay barn and constructed of cheap lumber. This stable was, however, the cleanest of the entire series. The stables were kept in good condition and the cows thoroughly groomed and clean. At milking time the udders were wiped with a dry cloth and considerable care taken to prevent dirt from falling into the milk. This fact is also clearly shown by the figures representing the dirt content as given in the table. It will be seen by these figures that the milk never went above the scale of 3 and was usually either 1 or 2. This milk averaged as clean as the milk of any of the thirty producers.

The stable of producer No. 1 is located at the side of the barn floor and is in fairly good condition. This is one of the best type of stables found. While the stable is in some respects better in arrangement than that of producer No. 2 the cows were not so well cared for and less care was taken to prevent dirt from getting into the milk. It is evident that the difference in care at milking time accounts for the difference in the amount of dirt contained in the milk of these two men.

Discussion of group 2.—All of the producers whose milk contained an average germ content greater than 100,000 and less than 500,000 per cubic centimeter are included in this group. More producers come within this group than any other, there being eleven or 36.6 per cent. of the entire number whose milk was examined. There is considerable range in the germ content of the milk of the different men which are grouped together here. The lowest average is that of producer No. 3 given in Table 27, this average being 105,800 bacteria per cubic centimeter. From this the average for the different men increases until we reach producer No. 13, Table 37, whose average for the entire series of experiments is 458,500 bacteria per cubic centimeter of milk.

TABLE 27.
Showing Composition of Milk of Producer No. 3.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 16, -	-	32.2	4.5	9.04	13.54	3	24	720,500	3,250	4	8,250	152,000	22
November 1, -	-	30.5	5.2	8.81	14.01	2	96	18,500	250	1	0	1,250	7
November 11, -	-	34.0	4.7	9.58	14.28	4	65	155,750	11,370	7	21,620	2,125	15
November 15, -	-	33.5	4.0	9.32	13.32	3	93	21,790	5,160	24	292	3,790	19
November 18, -	-	33.7	4.4	9.40	13.80	5	67	3,830	1,700	45	42	42	2
November 22, -	-	32.8	4.4	9.27	13.67	3	72	38,000	14,160	37	0	1,500	3
December 3, -	-	32.5	4.5	9.17	13.67	3	65	12,500	2,500	20	100	200	2
December 6, -	-	33.4	3.8	9.28	13.08	2	67	5,620	500	9	42	625	2
December 9, -	-	32.5	4.4	9.15	13.55	3	-	92,790	85,000	92	458	125	1
December 20, -	-	32.0	4.2	8.98	13.18	2	96	58,870	42,200	72	83	1,125	2
February 24, -	-	32.1	4.3	9.02	13.32	2	-	20,000	2,080	10	1,875	625	13
March 3, -	-	30.4	4.2	8.58	12.78	2	-	88,500	48,000	54	3,500	5,000	10
March 14, -	-	31.8	4.8	8.87	13.67	2	-	60,660	31,870	48	9,580	13,950	35
March 21, -	-	30.9	4.1	8.69	12.79	3	-	169,160	92,700	55	833	82,200	49
Average, -	-	32.3	4.4	9.08	13.47	3	72	106,820	24,340	33.9	3,330	18,900	13

TABLE 28.
Showing Composition of Milk of Producer No. 4.

Date.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent Liquefying Bacteria.
September 16,	47	33.2	4.8	9.35	14.15	2	32	107,080	32,910	31	1,000	1,000	2
September 30,	67	26.8	6.0	8.09	14.09	—	48	391,040	244,580	62	—	1,040	.3
October 25,	53	31.2	5.5	9.04	14.54	2	39	—	—	—	—	—	—
November 1,	45	30.5	6.4	9.05	15.45	3	62	29,160	833	3	0	2,080	7
November 11,	41	33.4	4.9	9.48	14.38	3	80	4,500	1,000	22	250	200	10
November 15,	47	33.2	5.8	9.60	15.40	3	84	34,580	4,410	13	708	833	4
Average,	50	31.4	5.6	9.10	14.67	2.6	58	113,370	66,760	26.2	390	1,030	4.7

TABLE 29.
Showing Composition of Milk of Producer No. 5.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per Cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per Cent. Liquefying Bacteria.
September 23.	55	31.4	4.9	9.00	13.90	—	—	50,830	4,790	9	1,040	5,830	13
October 4.	54	31.3	4.5	8.79	13.29	2	48	63,000	19,250	31	1,750	4,000	9
November 1.	49	32.5	4.9	9.25	14.15	2	48	86,250	625	0.7	208	8,330	10
November 4.	56	32.5	4.6	9.19	13.79	2	48	71,870	20,620	29	625	7,910	12
November 11.	55	32.4	4.6	9.17	13.77	3	65	1,614,330	654,160	41	8,000	1,500	6
November 15.	56	33.0	4.7	9.33	14.03	3	84	36,160	10,660	30	3,160	1,410	13
November 18.	47	32.3	4.8	9.23	14.03	4	67	27,330	3,080	11	583	3,160	14
December 2.	54	32.3	4.7	9.14	13.84	4	84	17,160	5,910	35	583	500	6
December 3.	50	32.7	4.8	9.28	14.08	4	72	39,910	11,750	29	1,080	4,750	15
December 9.	49	33.0	4.7	9.33	14.03	4	96	27,000	5,660	21	333	83	2
December 20.	49	32.5	5.5	9.37	14.87	2	—	19,660	5,250	27	333	333	3
February 24.	52	32.0	4.7	9.08	13.78	2	—	6,580	2,660	41	0	0	0
March 3.	51	31.9	4.6	9.05	13.65	3	—	15,000	8,250	55	500	500	7
March 14.	51	31.9	4.2	8.80	13.00	3	—	48,330	44,660	93	0	500	1
Average.	52	32.3	4.7	9.14	13.87	3	68	151,670	58,950	32.3	1,300	2,770	7.9

TABLE 30.
Showing Composition of Milk of Producer No. 6.

Date.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 23,	53	31.2	5.8	9.05	14.85	—	—	184,790	34,160	18	9,167	7,910	9
October 4,	55	30.4	5.1	8.66	13.76	3	48	46,450	11,250	24	—	2,290	6
October 25,	58	30.8	4.9	8.83	13.73	3	38	—	—	—	—	—	—
November 1,	65	31.7	5.0	9.02	14.02	4	61	115,000	10,000	9	18,330	0	16
November 11,	56	31.5	4.8	9.48	14.28	5	80	66,870	23,620	39	500	250	1
November 15,	54	32.3	5.1	9.23	14.33	5	84	60,250	17,250	28	0	625	1
November 18,	34	31.6	5.1	9.04	14.14	4	72	11,620	1,870	16	0	125	1
December 2,	54	30.8	4.8	8.80	13.60	3	72	329,100	224,100	68	2,550	9,750	4
December 3,	49	31.1	4.6	8.83	13.43	3	65	84,250	41,870	50	2,000	5,870	9
December 6,	50	29.9	4.5	8.54	13.04	3	72	47,250	10,750	23	375	1,500	4
December 29,	58	32.7	4.2	9.16	13.36	4	—	111,250	84,500	76	0	2,750	2
March 3,	59	29.9	4.9	8.60	13.50	4	—	333,250	247,000	74	2,250	12,620	4
March 21,	58	32.2	4.6	9.11	13.71	6	—	491,040	66,870	15	4,100	103,330	23
Average,	54	31.2	4.9	8.86	13.83	4	66	163,760	63,440	46.9	3,310	12,360	6.7

TABLE 31.
Showing Composition of Milk of Producer No. 7.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 23,	-	29.4	5.2	8.56	13.76	-	-	352,700	97,910	28	625	29,580	9
October 4,	-	30.3	5.3	8.70	14.00	3	41	167,910	88,330	53	1,040	2,290	2
October 11,	-	30.8	5.5	8.95	14.45	4	33	768,950	14,370	2	2,290	61,500	8
November 1,	-	33.1	5.0	9.39	14.39	5	57	156,870	13,330	8	1,660	25,830	18
November 11,	-	32.5	6.1	9.49	15.59	6	85	73,500	25,620	35	290	583	1
November 15,	-	34.0	6.0	9.84	15.84	4	117	102,080	23,620	23	1,290	4,410	6
December 2,	-	40	5.0	8.16	13.16	4	84	168,330	25,000	16	2,040	17,620	12
December 29,	-	43	4.7	9.58	14.28	4	120	1,110,660	18,750	2	1,590	72,330	7
January 3,	-	33.1	5.0	9.41	14.41	4	108	402,000	52,410	13	3,660	5,160	2
February 24,	-	48	4.5	9.40	13.90	3	-	115,410	21,040	18	1,660	8,330	9
March 7,	-	49	4.0	9.32	13.32	5	-	71,040	60,410	85	417	1,250	2
March 14,	-	51	4.2	8.93	13.13	2	-	16,450	7,080	43	0	0	0
March 21,	-	48	3.8	9.26	13.06	-	-	99,160	32,500	33	0	10,620	11
Average.	-	32.1	4.9	9.15	14.10	4	81	237,310	36,950	33.8	1,270	18,420	6.7

TABLE 32.
Showing Composition of Milk of Producer No. 8.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 19,	71	30.4	—	—	—	3	24	148,330	18,330	12	167	46,333	31
September 27,	66	30.8	—	—	—	2	24	1,058,540	22,700	2	2,080	28,542	3
October 25,	57	31.6	4.5	8.94	13.44	3	41	—	—	—	—	—	—
November 1,	52	33.1	4.4	9.27	13.67	3	57	87,910	417	0.4	—	8,750	10
November 4,	55	34.3	4.9	9.75	14.95	2	48	113,750	17,080	15	2,080	1,660	3
November 15,	48	32.9	4.8	9.33	14.13	3	93	24,870	3,870	16	1,000	625	7
November 22,	50	32.7	4.3	9.13	13.43	4	72	55,680	20,810	38	1,870	2,810	8
December 3,	41	32.9	4.9	9.35	14.25	6	64	281,250	67,750	24	5,370	53,875	21
December 9,	45	32.2	4.8	9.10	13.90	3	—	59,750	11,870	20	1,370	1,870	5
December 29,	41	32.9	4.4	9.25	13.95	3	—	1,708,000	446,000	26	7,120	99,750	6
February 28,	50	33.6	4.7	9.48	14.18	5	—	27,910	15,830	57	—	2,500	9
March 14,	52	32.0	4.4	8.85	13.25	4	—	64,160	28,750	45	416	3,330	6
March 21,	43	33.0	4.3	9.25	13.55	—	—	57,910	26,660	46	1,660	—	3
Average,	52	32.5	4.6	9.25	13.83	3.5	53	307,340	56,670	25.1	1,830	20,840	9.3

TABLE 33.
Showing Composition of Milk of Producer No. 9.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
October 4,	-	60	4.7	8.06	12.78	3	34	147,290	18,330	12	1,450	40,620	29
October 11,	-	28.0	4.2	7.94	12.14	5	32	2,324,000	135,000	6	3,370	5,000	0.3
November 4,	-	27.8	4.3	8.75	13.05	2	48	292,910	88,120	30	8,120	29,160	13
November 11,	-	59	4.3	8.79	13.29	3	72	60,830	21,040	35	833	0	1
November 15,	-	51	31.0	5.0	8.00	3	93	12,910	4,375	34	208	416	5
November 18,	-	49	29.8	4.6	8.56	6	65	16,660	2,080	13	4,060	0	24
November 18,	-	41	30.1	4.0	8.39	3	96	19,160	6,250	33	2,080	2,290	23
December 2,	-	43	29.8	4.4	8.52	3	64	41,040	7,910	19	833	5,200	15
December 6,	-	44	29.9	4.4	8.86	2	86	165,500	45,500	27	1,000	6,500	5
December 29,	-	44	31.2	4.6	8.55	2	86	294,160	137,500	47	8,750	27,910	12
January 3,	-	55	29.9	4.7	8.55	3	—	1,295,210	878,540	68	13,750	23,700	3
February 24,	-	54	31.3	4.9	8.94	3	—	190,410	60,830	32	4,370	4,580	5
March 3,	-	47	30.5	4.2	8.61	4	—	143,330	40,830	29	0	412	0.3
March 14,	-	49	28.9	4.7	12.81	3	—	272,500	115,000	42	1,870	5,000	3
March 21,	-	48	29.7	4.6	8.49	3	—	376,860	111,590	30.5	3,620	10,770	9.9
Average,	-	50	29.9	8.54	13.04	3	68						

TABLE 34.
Showing Composition of Milk of Producer No. 10.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 23,	-	32.9	3.9	9.17	13.07	-	-	53,330	6,040	11	1,042	3,330	8
October 4, -	-	34.2	4.3	9.50	13.80	2	48	35,410	11,870	31	833	2,910	11
October 23, -	-	29.1	4.2	8.25	12.45	2	48	-	-	-	-	-	-
November 1, -	-	33.1	4.1	9.21	13.31	2	65	25,830	3,540	14	1,250	1,660	11
November 11, -	-	33.0	4.8	9.35	14.15	3	83	653,330	2,200	0.3	0	167	0
November 15, -	-	35.2	5.0	9.81	14.81	3	84	4,055,000	1,250	0	0	0	0
November 18, -	-	34.1	5.2	9.68	14.88	3	67	2,500	458	18	708	375	43
December 2, -	-	30.4	5.0	9.48	14.48	3	84	1,330	0	0	42	0	3
December 6, -	-	33.8	5.2	9.68	14.88	3	84	10,830	1,410	13	500	542	10
December 9, -	-	32.6	5.7	9.41	15.11	2	-	2,000	875	44	0	42	2
December 20, -	-	32.9	4.7	9.30	14.00	1	-	130,200	458	0.4	0	127,200	98
February 28, -	-	32.2	5.5	9.29	14.79	3	-	20,500	6,750	33	83	1,750	9
March 7, -	-	32.4	4.5	9.14	13.64	2	-	63,560	21,310	33	2,250	6,870	14
Average,	-	32.8	4.8	9.33	14.11	2.4	70	431,160	4,690	16.5	660	12,070	18.4

TABLE 35.
Showing Composition of Milk of Producer No. 11.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 23,	57	29.7	4.5	8.54	13.04	—	—	152,910	55,410	36	2,080	11,870	9
September 30,	67	30.9	4.5	8.79	13.29	—	42	1,962,080	822,000	42	5,410	13,330	1
October 28,	38	33.0	4.0	9.19	13.19	3	63	77,080	14,160	18	5,410	1,250	9
November 4,	54	32.3	4.4	9.15	13.55	3	48	163,120	21,040	13	1,660	51,450	33
November 11,	49	30.7	5.6	8.93	14.53	3	83	29,410	6,000	20	167	250	1
November 18,	37	31.5	4.2	8.86	13.06	5	57	217,660	92,330	42	2,330	17,160	9
November 22,	45	32.6	3.7	9.01	12.71	4	72	161,330	72,580	45	917	5,750	4
December 3,	40	31.2	4.0	8.74	12.74	4	65	97,250	30,750	32	1,660	11,080	13
December 9,	46	31.4	4.0	8.82	12.82	4	—	69,250	43,500	63	333	833	2
December 20,	50	32.7	4.4	9.18	13.58	4	72	133,250	22,250	17	83	13,000	10
February 28,	50	31.8	4.4	8.98	13.38	4	—	86,080	51,830	60	666	3,330	5
March 7,	44	33.0	4.3	9.25	13.55	3	—	18,080	8,910	50	83	1,166	7
March 21,	48	32.4	5.2	9.29	14.49	7	—	2,374,160	1,135,830	48	3,000	107,830	5
Average,	48	31.8	4.4	8.90	13.36	4	63	466,280	182,810	53.5	1,830	18,330	8.3

TABLE 36.
Showing Composition of Milk of Producer No. 12.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 23,	-	56	4.9	9.25	14.15	—	—	180,000	45,620	25	5,620	7,500	7
September 27,	-	68	—	—	—	6	24	925,000	280,000	30	280,000	10,830	31
October 28,	-	49	5.4	8.09	13.49	4	96	316,660	16,660	5	0	16,660	5
Average, -	-	58	5.2	8.67	13.82	5	60	473,880	114,090	20.0	95,200	11,660	14.3

TABLE 37.
Showing Composition of Milk of Producer No. 13.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent Liquefying Bacteria.
September 19, -	70	30.3	—	—	—	3	24	1,567,000	559,600	36	5,080	24,250	2
October 4, -	55	31.4	5.5	8.99	14.49	3	48	102,000	24,160	23	10,000	8,330	18
October 11, -	—	—	4.6	8.35	—	4	42	2,370,000	1,213,700	51	35,410	26,250	3
October 28, -	38	29.0	4.8	—	13.15	4	48	630,830	231,660	37	14,100	9,160	4
November 4, -	51	28.1	4.5	8.04	12.54	3	63	79,160	5,830	7	0	1,660	2
November 11, -	44	31.2	4.2	8.77	12.97	3	63	69,580	28,330	41	417	2,500	4
November 15, -	46	30.5	4.5	8.67	13.17	4	64	147,700	61,450	42	9,580	10,410	14
December 3, -	47	30.0	4.1	8.46	12.56	3	65	62,700	4,160	7	2,910	3,750	11
December 9, -	43	30.2	3.8	8.40	12.20	3	87	8,750	1,450	17	625	416	12
December 20, -	52	27.2	3.6	7.61	11.24	3	—	123,330	41,870	34	2,290	5,020	19
February 24, -	51	31.9	4.3	8.98	13.28	4	—	114,370	37,370	33	250	2,250	2
March 3, -	44	32.2	4.5	9.09	13.59	4	—	614,660	261,330	43	25,660	13,330	6
March 14, -	47	31.4	4.6	8.74	13.34	5	—	458,500	243,370	53	15,500	9,500	5
Average, -	49	30.3	4.4	8.56	12.96	3.5	56	488,430	208,800	33.6	9,370	9,030	8.0

As would be expected the number of bacteria found in the milk of the different producers varies considerably from day to day as a result of variation in the conditions of cleanliness in obtaining and handling the milk for any given day. A study of Tables 27 to 37, however, shows that the increase in the average for each man is caused by a fairly constant increase in the numbers in the several experiments. In other words, those men whose milk shows the higher average for the entire series also shows the higher number in the majority of the daily tests. While this is true in general there are a few exceptions. For example, in Table 29 the number of bacteria normally found in the milk is no greater than the numbers found in Table 27, the greater average in this case being due to the extremely high germ content of the milk on November 11. In most cases, however, the average represents the normal condition of the milk of each producer.

Acid Producing Bacteria.—A study of the acid organisms in this group of tables shows that there is perhaps, even a greater variation in the numbers of acid bacteria from day to day than there is in the total numbers of bacteria. The number of acid bacteria found in any sample of milk seems to bear no direct relation to the total number of bacteria which the milk contained. This is shown both in the daily tests for the different producers and also in the average of the acid bacteria for the entire series of samples from each man. Not only do the actual numbers of acid bacteria vary greatly from day to day but the percentages also vary between wide limits, not infrequently there being less than 1 per cent. of acid bacteria while the same man's milk may on another day contain over 90 per cent. regardless of the total number of bacteria found in the milk. There seems to be no constant relation between the per cent. of acid bacteria and the total number of organisms contained in the different samples. It has already been brought out in a previous publication by this Station that the keeping quality of milk is not wholly dependent either upon the total number of bacteria or the percentage of acid organisms which it contains. The species of organisms is of greater importance than the actual number from the standpoint of its keeping qualities. The same condition is shown very strikingly in these tables

but while the percentage of acid organisms bears no close relation to the length of time which the milk will keep there does exist a fairly uniform relation between the percentage of acid bacteria and the amount of dirt which the milk contains. A study of these tables reveals the fact that a high dirt content normally goes with a high percentage of acid bacteria while a low dirt content is commonly accompanied by a low percentage of acid organisms. While this relation is not always uniform and while many exceptions may be found, this seems to be a moral condition. This condition is what would naturally be expected since the acid organisms which commonly sour milk are introduced from external sources with the dirt and dust which gain access to the milk. It is very natural, therefore, that a fairly uniform relation should exist between the amount of dirt and the percentage of acid organisms contained in the milk. It must be borne in mind that a portion of the dirt contamination of the milk had gone into solution and does not appear in the figures representing the relative dirt content in these tables. It is probable that the relation between the dirt content and the percentage of acid organisms would be more uniform if the actual total dirt contamination were determined. While it is not the purpose of this article to discuss the conditions under which the milk was produced, it may be said here that the stable conditions bear a fairly direct relation to the amount of dirt and the numbers of bacteria found in the milk of the different producers. The construction of some of the stables is fairly good and with more care in the management a much better quality of milk might be produced. A few of the stables in this group were of rather bad construction for the purpose of producing a good grade of milk.

Discussion of group 3.—This group contains the milk from those farms where the germ content for the entire series of tests was between 500,000 and 1,000,000 bacteria per cubic centimeter. The milk of but two producers comes in this group. The principal difference between the milk given in these tables and that given in the preceding group of tables lies in the greater germ content. It will be seen in Table 38 in the column marked "Total bacteria" that the variation from day to day is very marked. The lowest number which

TABLE 38.
Showing Composition of Milk of Producer No. 14.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 16, -	57	31.6	5.0	8.77	13.77	2	32	2,831,660	2,828,000	99	2,080	1,580	0.1
October 4, -	53	33.1	4.4	9.27	13.67	2	48	130,830	35,000	27	8,330	15,000	18
October 28, -	42	35.8	3.9	9.87	13.77	2	63	52,080	21,250	41	0	5,000	10
November 4, -	52	33.9	4.7	9.58	14.28	2	48	67,080	15,500	23	0	7,080	11
November 11, -	47	33.2	5.0	9.43	14.43	2	88	53,750	8,500	16	0	750	1
November 15, -	51	33.8	4.9	9.56	14.46	4	84	137,500	117,750	86	750	2,125	2
November 18, -	38	34.5	4.3	9.63	13.93	4	62	27,120	19,625	73	0	250	1
December 2, -	53	33.5	4.8	9.48	14.28	3	84	26,870	12,250	45	500	2,000	9
December 20, -	50	33.6	4.7	9.49	14.19	5	82	156,370	51,375	33	1,500	625	1
December 29, -	49	34.0	4.8	9.60	14.40	5	—	137,870	56,375	41	0	375	0.3
February 7, -	54	33.2	4.7	9.12	13.82	4	—	1,682,500	56,375	98	1,660	2,080	0.2
March 7, -	45	33.0	4.2	9.23	13.43	4	—	138,330	136,040	86	1,250	4,790	4
March 21, -	46	32.3	4.3	9.08	13.38	5	—	1,800,000	1,629,700	91	7,700	6,040	1
Average, -	48	33.5	4.6	9.38	13.88	3.4	66	558,610	505,620	58.4	1,830	3,670	4.5

TABLE 39.
Showing Composition of Milk of Producer No. 15.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 23, -	54	30.3	4.9	8.75	13.65	—	—	65,500	7,500	11	250	6,250	10
September 30, -	64	30.5	4.7	8.71	13.41	—	35	2,730,830	1,117,000	41	35,750	42,500	29
October 28, -	50	30.9	5.5	8.94	14.44	3	56	99,580	17,080	17	1,660	0	2
November 4, -	53	32.1	5.5	9.27	14.74	4	63	137,910	18,950	14	208	12,700	9
November 11, -	50	30.9	5.4	8.95	14.35	5	85	49,250	3,625	7	2,250	1,500	8
Average, -	56	30.9	5.3	8.93	14.13	4	60	616,610	232,830	18.0	8,035	12,690	11.6

the milk contained on any day is 26,870 on December 2d. From this relatively low number the germ content runs up to 2,831,000 on September 16. This is a higher number than was found in any of the samples in either group 1 or 2. The percentage of acid organisms is also higher in this case than any of those discussed up to this point. The variation in the percentage of acid organisms runs from 16 up to 99 while the average for the entire series of experiments is 58.4 per cent. This increase in the proportion of acid organisms indicates that the milk was either quite old or else had been kept at such warm temperatures that the bacteria had multiplied with great rapidity by the time the milk was delivered. In fact the milk of this producer was not infrequently sour when delivered and was rejected by the shippers. Producer No. 15 stopped sending his milk to the shipping station after a few samples had been obtained. The figures given in Table 39 present no striking features worthy of discussion at this point. The average germ content of his milk places it in this group. The dirt content is rather high, the average percentage of acid organisms is lower than for many of the other men. As already stated the chief difference in regard to these two producers is the somewhat greater germ content than is found in the preceding groups.

Discussion of group 4.—In this group are placed the results obtained from the milk which showed an average number of bacteria between 1,000,000 and 2,000,000 per cubic centimeter. The milk of seven men comes within these limits. This is 23.3 per cent. of the entire number of producers whose milk was being studied. The milk of these men was delivered at the shipping station at the same time as that contained in the preceding groups. The increased germ content must, therefore, be due to some other cause than the greater age of the milk. This cause is manifestly the difference in conditions under which the milk was produced and handled. A study of the total numbers as given in the different tables in this group shows a large variation from day to day and in some cases the germ content was relatively very low, being as low as 6,169 on November 18, Table 40. On December 20 the milk of the same man showed a germ content of considerably

TABLE 40.
Showing Composition of Milk of Producer No. 16.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Rat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 23.	-	30.7	5.2	8.93	14.13	-	-	91,000	18,000	20	3,500	7,500	12
September 30.	-	30.9	4.3	8.75	13.05	37	37	3,541,000	1,770,000	50	4,790	11,450	0.4
October 11.	-	31.8	4.6	9.02	13.62	5	40	582,290	2,500	0.4	7,080	6,870	2
November 1.	-	34.5	3.9	9.54	13.44	3	59	66,870	5,310	8	0	2,500	4
November 18.	-	32.5	4.3	9.13	13.43	5	71	6,160	1,080	18	0	417	7
November 22.	-	34.4	4.2	9.60	13.80	4	90	77,870	11,120	81	625	3,000	5
December 2.	-	32.6	4.0	9.10	13.10	3	96	63,160	6,580	10	0	1,250	2
December 3.	-	32.6	4.2	9.13	13.33	3	72	160,250	57,750	36	250	14,250	9
December 20.	-	32.9	4.7	9.30	14.00	2	56	9,269,000	8,630,000	93	5,250	91,750	1
December 29.	-	31.9	3.8	9.08	12.88	2	38	817,910	666,250	81	416	7,080	1
January 3.	-	32.6	4.4	9.17	13.57	2	86	134,160	27,580	21	1,250	9,600	8
February 24.	-	33.0	4.5	9.29	13.79	3	-	30,000	20,200	67	0	1,250	4
March 14.	-	33.8	4.5	9.33	13.83	3	-	111,750	11,000	10	0	3,250	3
March 21.	-	32.4	4.4	9.13	13.53	2	-	58,330	9,700	17	0	625	1
Average.	-	32.6	4.4	9.14	13.54	3	65	1,072,000	802,860	36.6	1,650	11,480	4.2

TABLE 41.
Showing Composition of Milk of Producer No. 17.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 23,	52	34.9	4.9	9.87	14.77	—	—	428,750	133,750	31	3,540	6,450	2
September 30,	68	31.1	5.6	9.01	14.61	—	—	10,352,000	9,150,000	89	2,910	33,540	0.4
October 11,	—	32.9	6.5	9.75	16.25	5	33	3,317,000	614,160	18	11,250	15,410	1
November 1,	48	35.5	6.5	10.17	16.67	3	72	88,000	13,000	15	0	2,000	2
November 18,	40	35.2	5.9	10.07	15.97	3	65	24,370	8,750	36	208	1,660	8
November 22,	38	34.5	5.1	9.78	14.88	3	87	60,200	16,040	27	1,870	2,500	7
December 2,	37	33.4	5.8	9.65	15.45	3	89	48,330	13,120	27	0	3,950	8
December 6,	39	34.1	5.0	9.64	14.64	3	72	249,370	25,410	10	625	17,910	7
December 20,	48	33.4	5.8	9.64	15.44	2	96	206,750	142,000	69	1,000	4,250	3
December 29,	43	35.0	5.2	9.80	15.00	3	36	558,950	187,290	34	9,580	81,250	16
January 3,	47	34.1	4.7	9.60	14.30	3	89	221,040	36,330	17	9,580	10,410	9
February 24,	48	32.4	5.1	9.27	14.37	2	—	95,500	57,500	60	1,000	18,000	20
March 3,	45	32.2	5.0	9.19	14.19	2	—	147,080	91,660	62	4,580	7,080	8
March 14,	47	32.3	4.7	8.99	13.69	3	—	349,580	169,160	48	416	17,910	5
Average,	46	33.6	5.4	9.62	15.02	3	67	1,153,000	761,440	38.8	3,330	16,880	6.9

TABLE 42.
Showing Composition of Milk of Producer No. 18.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 20,	54	31.3	5.0	8.77	13.77	2	—	273,330	36,450	13	1,040	5,410	2
September 27,	57	30.6	—	—	—	2	48	109,970	70,000	64	0	208	2
October 11,	—	—	4.7	—	—	5	66	2,495,000	788,000	32	14,750	15,000	1
October 28,	41	32.9	5.1	9.36	14.46	4	63	28,330	3,330	12	0	0	0
November 1,	47	33.2	5.2	9.43	14.63	3	62	50,830	417	0.8	0	417	1
November 18,	42	32.5	5.0	9.27	14.27	4	70	49,250	18,870	39	2,250	1,000	7
November 22,	53	33.1	5.4	9.47	14.87	4	87	58,050	6,300	11	1,500	1,800	6
December 2,	44	33.0	4.1	9.21	13.31	4	90	25,120	5,870	23	125	1,370	3
December 6,	49	33.5	4.5	9.42	13.92	2	67	30,000	7,120	24	250	625	6
December 9,	51	31.9	4.7	9.08	13.78	2	—	60,870	3,000	5	3,250	2,875	10
January 3,	43	32.6	4.2	9.13	13.33	3	65	5,904,000	5,810,000	98	2,620	31,000	0.6
February 24,	45	32.2	4.4	9.19	13.59	3	—	31,250	9,160	30	0	830	3
March 7,	44	33.2	4.6	9.11	13.71	3	—	9,100,000	9,087,000	99	417	3,750	0
March 21,	43	33.0	4.6	9.31	13.91	3	—	37,910	15,410	41	0	1,660	4
Average,	47	32.6	4.7	9.18	13.88	3	69	1,303,000	1,133,000	36.1	1,870	4,710	3.3

TABLE 43.
Showing Composition of Milk of Producer No. 19.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 19, -	65	29.6	—	—	—	9	24	1,004,000	58,660	6	7,000	23,250	3
September 27, -	63	30.4	—	—	—	4	24	3,384,000	1,505,000	44	3,750	31,250	1
September 30, -	65	30.7	4.6	8.69	13.29	—	34	4,320,000	527,500	12	14,250	11,000	6
October 4, -	52	32.0	4.1	8.96	13.06	2	48	6,076,000	4,998,000	82	29,160	119,160	2
October 28, -	43	32.1	4.0	8.96	12.96	4	63	488,580	108,330	22	12,500	20,330	7
November 4, -	58	32.7	4.4	9.15	13.55	3	48	312,500	44,160	11	830	117,500	57
November 22, -	43	32.4	4.2	9.11	13.31	9	87	560,410	426,250	76	0	0	0
December 3, -	39	30.7	4.3	8.68	12.98	6	72	102,910	65,830	64	0	0	0
December 6, -	38	32.0	4.3	9.00	13.30	6	84	364,580	300,830	83	417	2,910	1
December 29, -	49	32.5	4.4	9.15	13.55	6	—	116,250	33,750	29	830	1,660	2
February 24, -	51	31.0	4.6	8.81	13.41	6	—	1,335,000	1,280,000	96	3,330	0	0.2
March 3, -	48	31.5	4.5	8.92	13.42	6	—	33,330	12,500	37	0	5,000	15
March 14, -	55	30.4	4.6	8.49	13.09	7	—	85,830	17,500	20	3,330	8,330	15
March 21, -	47	31.9	4.2	8.96	13.16	7	—	64,160	12,500	20	3,330	0	4
Average, -	51	31.4	4.4	8.86	13.26	5	54	1,803,000	670,860	41.0	5,625	28,630	8.0

TABLE 44.
Showing Composition of Milk of Producer No. 20.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 16,	-	31.5	4.0	8.57	12.57	2	44	5,573,000	1,202,000	22	5,500	6,250	0.2
September 30,	-	30.3	4.9	8.75	13.65	-	45	3,083,000	722,080	23	1,875	4,160	0.2
October 4,	-	30.5	5.1	8.66	13.76	3	48	591,660	229,160	39	18,750	25,000	7
October 11,	-	32.3	5.3	9.28	14.58	3	41	11,603,000	8,660,000	75	20,000	41,660	1
November 1,	-	34.4	5.0	9.76	14.76	3	62	45,000	5,830	13	5,000	1,660	15
November 22,	-	32.3	5.6	9.39	14.99	3	86	107,060	21,000	20	5,060	8,430	13
December 3,	-	32.6	5.7	9.43	15.13	4	70	91,500	13,000	14	1,125	5,125	7
December 6,	-	33.1	5.2	9.43	14.63	4	64	522,500	55,000	11	13,330	30,000	8
December 9,	-	34.3	4.7	9.71	14.41	2	-	20,875	4,500	22	0	500	2
December 20,	-	33.5	4.7	9.46	14.16	1	82	76,750	10,250	13	125	2,125	3
January 3,	-	32.2	4.5	9.09	13.59	2	104	95,000	26,450	28	2,080	5,410	8
February 28,	-	32.1	5.0	9.16	14.16	2	-	800,375	778,250	97	250	1,875	0.3
March 7,	-	33.0	4.9	9.37	14.27	1	-	37,500	25,250	67	0	4,625	12
March 21,	-	33.4	5.0	9.49	14.49	2	-	59,000	14,120	24	625	2,750	6
Average,	-	32.5	5.0	9.22	14.22	2.4	65	1,621,000	840,530	33.5	5,280	9,970	5.9

TABLE 45.
Showing Composition of Milk of Producer No. 21.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 16,	-	30.6	3.6	8.49	12.09	3	36	197,950	37,125	19	875	3,290	2
September 27,	-	30.5	-	-	-	2	24	382,080	126,040	33	416	7,290	2
September 30,	-	69	4.0	8.44	12.44	-	32	7,940,000	52,810	0.6	3,250	65,250	1
October 11,	-	32.5	4.0	9.07	13.07	4	38	1,446,000	1,115,000	77	21,000	21,000	2
November 1,	-	51	3.8	9.40	13.20	4	59	24,000	250	1	1,000	1,500	10
November 22,	-	46	3.1	9.01	12.11	6	72	1,260,000	1,207,000	96	3,050	2,250	0.5
December 2,	-	42	3.2	8.78	11.98	6	72	5,756,000	5,753,000	99	250	790	0
December 6,	-	48	2.9	8.98	11.88	6	67	190,250	31,660	17	2,950	2,910	3
December 9,	-	37	2.6	8.16	11.76	6	-	38,700	6,625	17	625	1,410	5
December 20,	-	34	3.9	9.05	12.95	7	96	76,700	20,330	27	166	2,375	3
March 21,	-	43	3.8	8.67	12.47	7	-	1,318,000	1,165,000	88	8,950	18,330	2
Average,	-	49	3.5	8.90	12.40	9	55	1,683,000	885,100	43.1	3,620	9,800	2.8

TABLE 46.
Showing Composition of Milk of Producer No. 22.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Rat.	Solids, not Rat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 16,	-	31.0	3.9	8.67	12.57	2	44	97,580	18,000	18	1,410	10,410	12
September 27,	-	30.8	-	-	-	2	24	10,606,000	10,606,000	99	2,080	28,330	0.3
October 28,	-	31.0	4.6	8.81	13.41	2	48	689,160	398,330	58	7,500	6,060	2
November 4,	-	31.3	4.2	8.86	13.06	2	48	3,452,000	2,651,000	77	11,250	28,330	1
November 18,	-	31.0	4.8	8.85	13.65	3	57	748,330	235,000	31	8,330	5,000	2
November 22,	-	31.7	4.4	8.90	13.30	4	72	352,500	70,000	20	7,500	25,000	9
December 2,	-	30.5	4.5	8.67	13.17	2	84	1,118,000	314,000	28	219,000	97,000	28
December 6,	-	32.0	4.8	9.10	13.90	2	67	183,330	60,000	33	1,660	5,830	4
December 20,	-	32.5	4.5	9.17	13.67	2	109	545,000	64,160	12	11,660	92,500	19
January 3,	-	30.4	4.2	8.59	12.79	2	64	1,600,000	1,135,000	71	23,330	6,660	2
February 28,	-	31.7	4.5	8.97	13.47	1	-	21,660	5,830	27	2,080	833	14
March 7,	-	31.2	4.2	8.78	12.98	3	-	2,515,000	2,306,000	92	14,500	39,000	2
March 21,-	-	31.2	4.5	8.84	13.34	1	-	1,130,000	1,032,000	91	833	179,580	16
Average,	-	31.3	4.4	8.88	13.88	2	62	1,773,000	1,463,000	60.5	16,240	40,390	8.5

over 9,000,000 bacteria per cubic centimeter. In the majority of tests as shown in this group of tables the germ content averages materially higher than was found in the earlier groups and the average given in connection with each table represents fairly well the general bacterial condition of the milk of the given producer. The average percentage of acid organisms in this group is considerably higher than was found in the preceding groups. This indicates that at least a portion of the increase in total germ content is due to the rapid development of the acid bacteria in the milk. The dirt content of some of the samples is rather high while on the other hand some of the samples were among the cleanest ones found, the average for the group being practically the same as for group 2. It is evident from this that the increase in bacteria is not due in this case to a greater dirt contamination and must, therefore, be attributed to the rapid development of the acid bacteria.

Discussion of group 5.—This group includes the milk from those farms where the average germ content was above 2,000,000 bacteria per cubic centimeter, the milk from eight farms exceeded this number and is therefore included in this group. This is 26.6 per cent. of the whole number of farms from which milk was studied. The smallest average number of bacteria for the milk of any of the men included in this group is 2,745,000 as shown in Table 47. The lowest test for this man is 220,000 on March 23, while his highest test occurred on January 1, when his milk contained 19,920,000 bacteria per cubic centimeter. The milk of producer No. 30 has the highest average bacterial content. The results obtained from his milk are given in Table 54, where the average is shown to be 19,174,000. The germ content of this milk did not fall below 1,000,000 in any test and the highest point was reached on October 11, when the milk contained the enormous number of over 88,000,000 bacteria per cubic centimeter. This is the highest number found in any of the tests.

The high percentage of acid producing bacteria found in the milk of this group is very noticeable, it being much higher in this group than in any of the preceding groups. In individual experiments the acid producing organisms not infrequently constitute as high as 99 per cent. of all the organisms present in the milk.

TABLE 47.
Showing Composition of Milk of Producer No. 23.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent Liquefying Bacteria.
September 23,	56	31.5	4.8	8.98	13.78	—	—	266,660	185,000	62	830	5,000	2
October 4,	58	31.7	4.7	9.08	13.78	—	40	1,814,000	431,660	24	6,450	16,660	1
October 25,	56	31.5	5.2	9.06	14.26	2	38	—	—	—	—	—	—
October 28,	47	33.2	4.5	9.34	13.84	2	48	205,000	23,330	11	5,000	13,330	9
November 11,	38	32.5	4.1	9.09	13.10	5	80	251,450	83,540	33	5,620	3,540	4
November 15,	46	32.3	4.8	9.18	13.98	5	84	236,040	42,910	18	10,000	9,580	8
November 22,	42	33.4	4.4	9.40	13.80	5	68	3,438,000	3,285,000	96	8,000	11,250	1
December 3,	35	32.2	4.1	9.00	13.10	3	72	566,250	103,750	18	6,660	112,700	21
December 9,	36	30.5	4.5	9.42	13.92	3	80	1,091,000	395,000	36	40,625	67,700	10
January 3,	46	33.1	4.0	9.22	13.22	3	—	13,920,000	13,903,000	99	1,070	10,200	0.1
February 28,	49	32.5	4.7	9.21	13.91	5	—	8,163,000	8,111,000	99	6,660	33,330	0.5
March 7,	37	32.4	3.3	8.90	12.20	3	—	220,000	68,330	31	0	1,660	1
Average,	46	32.2	4.4	9.18	13.58	3.5	64	2,745,000	2,421,000	48.0	8,260	26,900	5.2

TABLE 48.
Showing Composition of Milk of Producer No. 24.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Rat.	Solids, not Rat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 16,	61	29.1	4.2	8.23	12.43	2	24	449,000	1,250	3	4,660	5,160	2
October 4,	58	30.8	4.4	8.77	13.17	2	37	9,787,500	9,773,750	99	4,680	8,430	0.1
October 11,	—	31.3	4.7	8.93	13.63	4	38	5,433,330	2,487,500	46	21,450	22,290	1
November 4,	59	33.9	4.1	9.46	13.56	1	63	223,330	1,660	0.7	5,830	18,330	11
November 18,	41	31.4	3.8	8.77	12.57	3	65	260,830	47,500	18	15,000	1,660	6
November 22,	45	31.8	4.0	8.94	12.94	2	68	6,205,830	3,171,660	51	21,250	99,000	2
December 9,	37	31.1	4.4	8.77	13.17	3	—	1,000,000	40,000	4	0	7,910	1
Average,	50	31.9	4.2	8.87	13.07	2.4	49	3,937,110	2,217,600	32.4	10,413	23,850	3.3

TABLE 49.
Showing Composition of Milk of Producer No. 25.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 23,	51	31.0	5.0	8.89	13.89	—	—	51,660	6,450	12	208	830	2
October 4, -	53	30.2	4.5	8.54	13.04	2	48	868,540	60,625	7	625	25,625	3
November 4, -	45	30.4	5.8	8.93	14.73	4	48	1,006,000	338,750	38	2,500	66,250	7
November 11, -	39	31.2	5.9	9.11	15.01	4	85	100,410	10,830	11	417	2,910	3
December 9, -	35	30.4	5.5	9.12	14.62	2	—	1,419,000	330,000	23	69,000	91,500	11
December 20, -	37	29.9	5.9	8.80	14.70	3	96	982,500	138,330	14	3,750	136,250	14
December 29, -	41	30.1	5.0	8.67	13.67	4	36	6,863,000	2,446,000	36	40,410	533,330	8
January 3, -	43	28.4	5.2	8.29	13.49	4	66	17,593,000	8,206,000	47	9,100	501,660	3
Average,	43	30.2	5.4	8.74	14.14	3.3	63	3,610,000	1,443,000	23.5	16,780	169,780	6.4

TABLE 50.
Showing Composition of Milk of Producer No. 26.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Percent Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Percent Liquefying Bacteria.
September 19,	73	29.5	—	—	—	3	24	43,776,000	43,666,000	99	0	109,500	0.2
September 27,	66	30.7	—	—	—	3	24	4,209,000	2,460,000	58	3,750	44,790	1
October 28,	47	33.2	4.8	9.40	14.20	4	48	1,072,000	179,160	19	6,660	103,330	10
November 11,	40	31.7	5.0	9.06	14.06	4	85	641,660	61,250	10	7,080	23,750	5
November 15,	49	32.5	4.7	9.21	13.91	5	84	120,410	7,500	6	15,830	3,750	16
November 18,	41	32.9	5.0	9.39	14.39	5	65	27,080	5,830	22	1,660	0	6
November 22,	53	32.1	4.5	9.04	13.54	5	63	6,715,000	6,424,000	96	22,500	21,250	1
December 3,	33	34.1	4.5	9.56	14.06	4	65	384,000	128,000	33	18,500	10,500	8
December 6,	45	33.0	4.5	9.29	13.79	4	72	30,410	12,080	39	0	833	3
January 3, -	35	32.7	4.4	9.20	13.60	4	86	690,830	182,080	26	31,250	42,910	11
February 28,	40	31.7	5.0	9.07	14.07	5	—	91,250	34,160	37	3,330	4,160	8
March 7, -	40	31.7	4.0	8.87	12.87	4	—	162,080	113,750	70	2,080	14,580	10
Average,	47	32.2	4.6	9.25	13.85	4	62	4,826,000	4,439,000	43.0	9,889	31,610	6.6

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TABLE 51.
Showing Composition of Milk of Producer No. 27.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 23, -	59	30.9	4.3	8.75	13.05	—	—	727,500	440,000	61	5,830	10,000	2
September 30, -	73	30.7	4.5	8.92	13.42	—	32	37,923,000	37,889,000	99	13,330	20,830	1
October 11, -	—	—	4.6	—	—	4	34	39,930,000	39,929,000	99	417	208	0
October 28, -	51	32.9	5.6	9.46	15.06	3	80	381,660	96,660	25	5,830	20,000	7
November 4, -	54	34.2	4.9	9.62	14.52	2	48	2,072,000	1,397,000	67	6,250	62,080	3
November 15, -	57	32.6	5.2	9.33	14.53	5	84	655,000	95,000	14	10,000	37,500	3
November 22, -	53	34.0	5.0	9.64	14.64	5	72	2,100,000	552,500	26	13,750	40,000	7
December 3, -	43	35.5	5.6	10.05	15.65	4	96	1,995,000	398,330	20	10,830	79,160	5
December 9, -	50	35.5	5.5	10.11	15.61	2	100	756,250	328,750	43	5,000	23,750	4
December 20, -	42	30.1	5.0	8.66	13.66	2	100	1,685,000	932,500	55	2,500	78,330	5
Average, -	54	32.9	5.0	9.46	14.46	3.4	69	8,923,000	8,806,000	50.9	7,376	37,180	3.7

TABLE 52.
Showing Composition of Milk of Producer No. 28.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 16,	-	53	5.1	8.91	14.01	5	24	5,923,000	3,024,000	57	8,250	34,250	1
September 27,	-	59	30.9	-	-	4	34	7,505,000	4,675,000	62	10,830	17,700	4
September 30,	-	66	29.8	5.0	13.64	4	34	16,645,000	1,380,000	8	46,875	33,430	0.4
October 25,	-	54	31.3	4.9	13.85	4	24	-	-	-	-	-	-
November 1,	-	48	33.4	5.3	14.87	5	48	1,062,000	14,160	1	14,160	85,830	9
November 18,	-	41	33.8	4.0	13.44	4	57	1,787,000	818,750	46	43,750	18,750	3
November 22,	-	40	33.7	4.0	13.32	4	61	6,901,000	5,122,000	74	66,660	74,160	2
December 3,	-	36	34.3	4.8	14.47	6	60	4,205,000	1,862,000	44	105,000	115,000	5
December 6,	-	40	33.7	6.0	15.71	5	64	4,820,000	956,000	20	164,000	246,000	9
December 29,	-	33	34.0	4.2	13.68	3	48	58,133,000	55,697,000	91	75,000	164,580	0.4
January 3,	-	38	32.0	4.7	13.78	4	80	5,643,000	1,569,000	28	166,660	208,330	7
February 24,	-	44	33.0	4.2	13.43	3	-	421,250	398,750	95	416	2,290	0.6
March 3,	-	52	32.0	4.4	13.42	4	-	6,308,000	6,254,000	99	14,580	8,330	0.3
March 14,	-	38	32.5	4.0	12.02	4	-	487,500	243,330	70	0	5,000	1
Average,	-	46	33.3	9.19	13.89	4	49	9,228,000	6,316,000	53.5	55,080	77,870	3.3

TABLE 53.
Showing Composition of Milk of Producer No. 29.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 19,	75	28.9	—	—	—	1	24	3,025,000	314,660	10	330	29,750	1
September 27,	66	30.8	—	—	—	2	24	44,890,000	975,000	2	417	34,790	0.1
October 11,	—	—	4.3	—	—	4	34	14,325,000	5,204,000	36	184,370	65,620	2
October 28,	45	29.5	3.9	8.29	12.19	4	48	4,470,000	2,443,000	55	17,500	9,160	1
November 4,	56	32.5	4.5	9.17	13.67	3	60	1,522,000	71,660	5	60,830	206,660	18
November 15,	62	31.3	5.6	9.10	14.70	6	84	404,160	18,330	5	1,660	32,500	8
November 28,	63	27.9	4.8	8.10	12.90	5	62	—	—	—	—	—	—
December 2,	51	30.0	4.6	8.56	13.16	6	72	1,367,000	726,660	53	12,500	44,160	4
December 6,	54	29.3	5.3	8.58	13.88	6	72	115,000	27,500	24	0	5,830	5
December 9,	42	30.1	5.0	8.64	13.64	5	—	31,000,000	30,431,000	98	14,160	20,830	0.1
December 20,	56	30.0	5.4	6.72	12.12	6	65	20,953,000	20,436,000	98	20,830	71,660	0.4
January 3, -	52	31.1	4.7	8.85	13.55	6	70	17,876,000	17,298,000	97	30,000	18,000	0.3
February 24,	51	32.9	3.8	9.13	12.93	6	—	125,000	45,000	36	0	8,330	7
March 3, -	62	30.3	4.1	8.52	12.62	6	—	3,113,000	2,025,000	65	0	26,660	1
Average.	57	30.4	4.7	8.61	13.21	5	56	11,014,370	6,155,200	45.0	26,350	44,150	3.7

TABLE 54.
Showing Composition of Milk of Producer No. 30.

DATE.	Temperature of Milk.	Specific Gravity at 60° F.	Fat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Per cent. Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liquefying Bacteria.
September 16,	-	28.9	4.6	8.31	12.91	6	24	25,053,000	25,045,000	99	1,950	6,500	0
September 27,	-	29.8	-	-	-	5	24	18,000,000	18,000,000	99	0	2,500	0
September 30,	-	68	4.7	8.58	13.28	32	32	28,281,000	28,222,000	99	7,500	31,660	0.1
October 4,	-	63	4.9	8.62	13.52	6	40	2,966,000	1,787,000	60	97,010	12,500	4
October 11,	-	-	5.2	-	-	5	32	88,291,000	86,650,000	98	77,080	102,080	0.2
October 28,	-	53	4.8	9.60	14.40	5	48	2,020,000	500,000	25	58,330	95,830	8
November 4,	-	59	5.0	9.14	14.14	3	48	5,571,000	2,760,000	50	39,160	47,500	2
December 2,	-	39	4.7	9.01	13.71	4	72	1,363,000	421,660	31	36,660	91,660	2
December 6,	-	43	5.0	9.27	14.27	6	72	1,021,000	451,600	44	26,600	30,000	6
Average,	-	55	4.9	8.85	13.75	9	44	19,174,000	18,204,000	67.0	38,280	46,690	3.3

The milk in this group also contains a higher average amount of insoluble dirt than does that of any of the preceding groups. The facts shown in these tables are sufficient to portray very clearly the conditions surrounding the production and subsequent handling of this milk. The construction of many of the stables was entirely unsuited for the production of good milk. In many cases there were no windows in the stable for letting in light and no drop behind the cows. The cows themselves were badly covered with filth and the entire surroundings were wholly unfitted for the production of any article intended for human food. As stated earlier in this report the relation between stable conditions and the quality of the milk will be discussed in another report and need not be dwelt upon here.

GENERAL DISCUSSION.

The Total Bacteria.—It is only during the past few years that the question of the wholesomeness of milk has received any consideration on the part of those having in charge the health of the people, except as its wholesomeness might be affected by the use of chemicals in preserving the milk. Now that it is definitely known that some of the most serious of human diseases are sometimes spread by the disease producing organisms being carried in milk attention is being turned to the conditions under which market milk is produced. Thus far most of the bacteriological work with milk has been done by city physicians upon milk after it has reached the city. Much of this milk is shipped long distances and is many hours old when the sample is taken so that the results do not necessarily represent even approximately the bacterial conditions of the milk as it left the producer. The results given in this paper on the contrary represent the bacterial condition of the milk as it was actually delivered each day by the individual producers and the conditions must be due to methods of production and not to changes which have taken place during transportation. What the condition of this milk would be by the time it reached the city and was delivered to the consumer one can only imagine. In fact it was found to be impossible to keep most of this milk sweet long enough to get it to the city even when placed in cars and iced as soon as received. It

was found necessary to pasteurize it before shipping to the city. It was also run through a separator in order to remove a portion of the insoluble filth. If the total bacteria found in these milks be compared with the figures given in the fore part of this article for the bacterial content of market milk as examined in the cities it will be seen that many of these milks were in worse condition when delivered to the shipping station than the average milk is when it reaches the cities. It must not be supposed, however, that the figures given in this paper represent the average quality of Connecticut milk. On the contrary it is probable that they represent about the worst quality, from a sanitary standpoint, of any milk produced in the state. This is due to the fact that the producers are largely foreigners who are unfamiliar with the necessary methods for and ignorant of the importance of producing milk of low dirt and bacterial content. The examination of milk of some other sections shows that many of our dairymen are producing and delivering to the consumers milk which is of excellent quality as determined by the dirt and bacterial content.

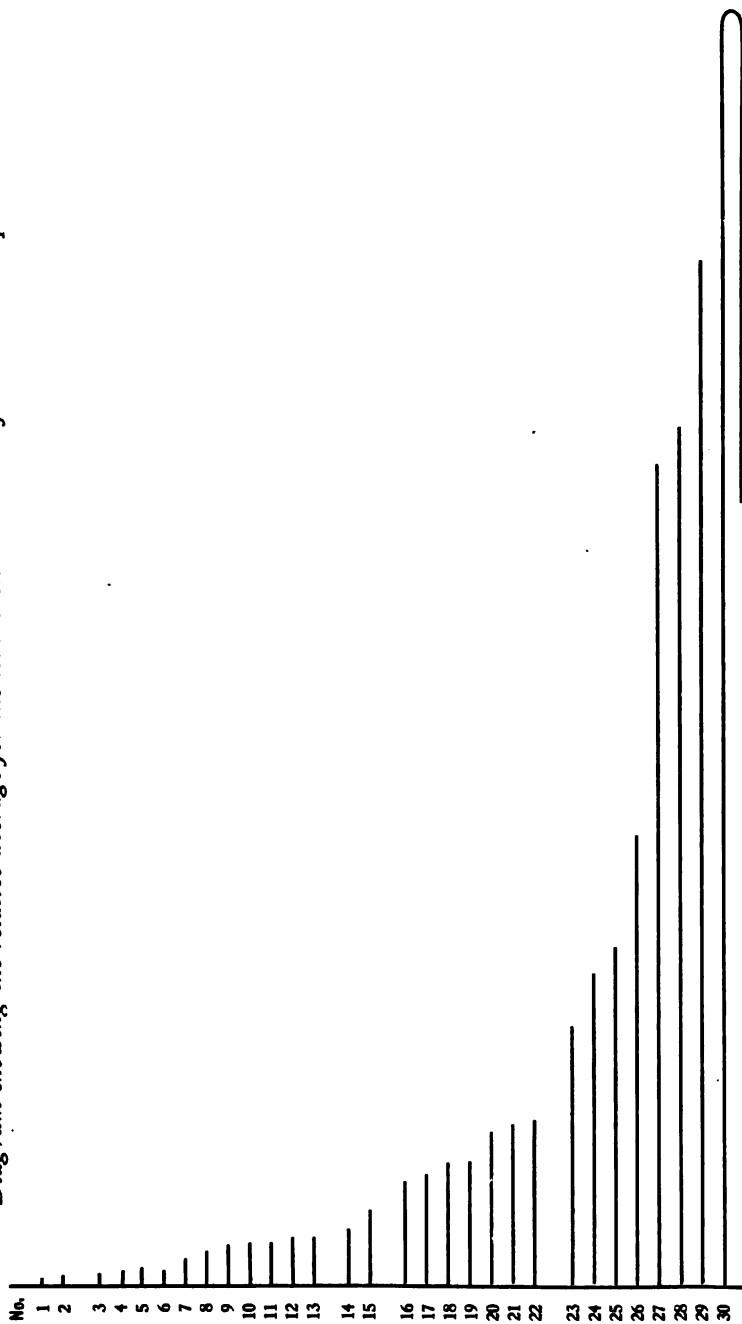
The principal value of the tables in this report lies in the fact that they show the actual daily condition of each man's milk together with the limits between which variations take place. The averages are of far less value than are the individual experiments since they seldom tell more than a part of the truth and in some cases are actually misleading. Yet for those who do not care to study the individual experiments a summary table is inserted here which gives in a condensed form the averages for the foregoing tables. This summary table is followed by a chart showing the relative average bacterial content of the milk from the thirty different producers.

Chemical Composition of the Milk.—As was stated in the early part of this paper the percentage of fat in each sample of milk tested was determined by the Babcock method. The uniformly high fat content of the milk may be easily seen by a study of the various tables while the average for each producer is given in Table 55. Out of the thirty producers whose milk was tested the lowest average for any man is 3.5 per cent. for producer No. 21, and this is considerably above the legal standard as set by the State Experiment Station at

TABLE 55.—Summary Showing Averages Given in the Preceding Tables.

Group.	No. of Producers.	Temperature of Milk.	Spec. Gravity at 60° F.	Rat.	Solids, not Fat.	Total Solids.	Relative Dirt Content.	Hours to Curdling.	Total Bacteria.	Acid Bacteria.	Percent Acid Bacteria.	Rapid Liquefying Bacteria.	Slow Liquefying Bacteria.	Per cent. Liq. Bacteria.
1	1.	50	32.3	4.1	9.02	13.07	4.5	67	61,660	19,740	35.7	2,640	3,780	8.6
	2.	48	33.0	4.9	9.42	14.31	2.0	67	81,050	24,640	34.3	1,340	4,417	8.0
	3.	47	32.3	4.4	9.08	13.47	3.0	72	105,820	24,340	33.9	3,330	18,900	13.0
2	4.	50	31.4	5.6	9.10	14.67	2.6	58	113,270	56,750	26.2	1,390	1,030	4.7
	5.	52	32.3	4.7	9.14	13.87	3.0	68	151,670	56,950	32.3	1,300	2,770	7.9
	6.	54	31.2	4.9	8.95	13.83	4.0	66	153,760	64,440	45.9	3,310	12,250	6.7
3	7.	49	32.1	4.9	9.15	14.10	4.0	81	227,310	36,950	33.8	1,270	18,420	6.7
	8.	52	32.5	4.6	9.25	13.83	3.5	53	307,340	56,670	25.1	1,930	20,840	9.3
	9.	50	29.9	4.5	8.54	13.04	3.0	68	376,850	111,520	30.5	3,620	10,770	9.9
4	10.	49	32.8	4.8	9.33	14.11	2.4	70	421,160	4,600	16.5	560	12,070	18.4
	11.	48	31.8	4.4	8.90	13.38	4.0	63	426,280	182,810	53.5	1,830	18,330	8.3
	12.	58	30.7	5.2	8.67	13.82	5.0	60	473,890	114,090	20.0	95,200	11,660	14.3
5	13.	49	30.3	4.4	8.56	12.96	3.5	56	488,430	208,800	32.6	9,370	9,030	8.0
	14.	48	33.5	4.6	9.38	13.98	3.4	66	558,610	505,620	58.4	1,830	3,670	4.5
	15.	56	30.9	5.2	8.92	14.12	4.0	60	616,610	232,930	18.0	8,025	12,590	11.6
6	16.	46	32.6	4.4	9.14	13.54	3.0	65	1,072,180	802,650	36.6	1,655	11,490	4.2
	17.	46	33.6	5.4	9.62	15.02	3.0	67	1,153,390	761,440	38.8	3,327	15,880	6.9
	18.	47	32.5	4.7	9.18	13.88	3.0	69	1,303,180	1,133,030	35.1	1,872	4,710	3.3
7	19.	51	31.4	4.4	8.86	13.26	5.0	54	1,303,560	670,850	41.0	5,625	28,630	8.0
	20.	48	32.5	5.0	9.22	14.22	2.4	65	1,621,980	840,530	33.5	5,260	9,970	5.9
	21.	49	32.1	3.5	8.90	12.40	5.0	55	1,693,730	865,100	43.1	3,920	9,900	2.8
8	22.	49	31.3	4.4	8.88	13.28	2.0	62	1,773,790	1,453,590	50.5	16,240	40,390	8.5
	23.	46	32.2	4.4	9.18	13.58	3.5	64	2,745,689	2,421,276	48.0	8,268	25,909	5.2
	24.	50	31.3	4.2	8.87	13.07	2.4	49	3,337,119	2,217,619	32.4	10,413	23,259	3.3
9	25.	43	30.2	5.4	8.74	14.14	3.3	63	3,610,708	1,442,291	23.5	15,760	169,797	6.4
	26.	47	32.2	4.6	9.25	13.85	4.0	62	4,826,771	4,439,576	43.0	9,389	31,614	6.6
	27.	54	32.9	5.0	9.46	14.46	3.4	69	8,822,666	8,206,021	50.9	7,375	37,187	3.7
10	28.	46	33.3	4.7	9.19	13.89	4.0	49	9,228,019	6,316,224	53.5	55,093	77,975	3.3
	29.	57	30.4	4.7	8.51	13.21	5.0	56	11,014,372	6,155,205	45.0	26,356	44,154	3.7
	30.	55	31.2	4.9	8.85	13.75	5.0	44	19,174,555	18,204,435	67.0	38,287	46,694	3.3

Diagram showing the relative average for the total bacteria in milk of the individual producers.



New Haven. This is the only producer whose milk averaged below 4 per cent. in fat and seven averaged above 5 per cent. No. 4 being as high as 5.6 for the entire series of tests. In the entire series but four individual tests fell below the standard of 3.25. These all occurred in the milk of one man, producer No. 21, and it will be seen that these figures are in strong contrast to his average test. His other tests were high enough to bring his final average up to 4.9 per cent.

For solids, not fat, the milk of these thirty producers all averaged above the standard of 8.50. More than half of the producers averaged above 9 per cent. for the solids, not fat. In the entire series of experiments but fifteen individual tests fell below the standard. This is, of course, a very small percentage of the entire number of samples tested. The milk of all of these men averaged considerably above the standard of 12 per cent. for total solids, the lowest average being 12.40 for producer No. 21. Only two men had an average below 13 per cent. while eight were above 14 per cent. and one was slightly over 15 per cent. In the entire series only one sample of milk showed a total solids below the standard of 12 per cent. This is an excellent showing for the chemical qualities of this lot of milks.

It is a striking fact that the dirt content increases quite uniformly with the increase of bacteria. This is true if we consider the averages for the different groups of producers, the dirt content increasing quite uniformly with the exception of group 4 which is somewhat below groups 2 and 3. Some of the milk in this group was comparatively clean while the numbers of bacteria ran high. It is evident that the large numbers of bacteria were due in many cases to the temperature at which the milk was kept rather than to contamination through insoluble dirt. In spite of this general relation between the dirt and the number of bacteria there is, however, great lack of uniformity in the tests of any individual producer. At the same time that the bacterial and dirt content increases with the different groups the keeping qualities of the milk uniformly decrease, there being an average difference between the first and fifth groups of ten hours in the keeping quality of the milk. Judged from the chemical standpoint alone all of the milk of these producers must be considered of excellent quality but when the dirt contamination and the numbers of bacteria are taken into account it is apparent that much of this milk is of very inferior quality.

METEOROLOGICAL OBSERVATIONS AT STORRS,
AND GENERAL WEATHER AND
CROP REVIEW.

REPORTED BY W. A. STOCKING, JR.

For the sixteen years preceding 1904 this Station kept continuous weather records, making observations three times each day in accordance with the directions of the U. S. Weather Bureau. The results of these records have been given each year in the annual report. This work was carried on at a cost of considerable labor and expense on the part of the Station. At the beginning of 1904, after consultation with the New England section of the Weather Bureau, it was deemed advisable to omit a part of the observations formerly recorded by this Station. It has been found by the Weather Bureau that temperature observations taken three times daily are not necessary in order to get a fairly correct idea of temperature conditions. The only data now required by the Weather Bureau of its voluntary observers consists of the daily maximum and minimum temperature readings and a record of the precipitation. This Station has, therefore, during the past year, recorded only the maximum and minimum temperatures each day together with the amount and time of rainfall. For this work the self-registering maximum and minimum thermometers and the rain gauge used by the Weather Bureau are used. This greatly simplifies the matter of taking observations, and, of course, makes it necessary to omit from our annual report certain data that has been previously given.

The mean temperature, together with the maximum and minimum, and the amount and distribution of precipitation are the weather phases which bear most directly upon crop production and agricultural problems in general, and this data is considered of sufficient value to warrant the continuance of this work on the part of the Station. The records now in the

possession of the Station are of considerable value in teaching the subjects of meteorology and climatology, and these records are frequently drawn on for class instruction.

The results of the observations taken at Storrs during 1904 are given in Table 56.

The total precipitation for the year at Storrs was 40.19 inches. This is 8.46 inches less than the total amount for the year 1903, and 7.24 inches less than the average for the past sixteen years. Seven months out of the twelve had a smaller rainfall than the average for the same months during the sixteen years preceding. The principal shortage occurred in May, July and November. This is the smallest total rainfall for any year since 1899, and only three times has it gone below this amount during the sixteen years preceding. The total rainfall for each year since 1888 is given in Table 60. In spite of the large total annual shortage the rainfall was quite uniformly distributed throughout the season, there being no periods of decided drought as in some other years.

The Station has been helped during the growing season by the coöperation of men in different parts of the state who have continued to send us the records of the rainfall for their sections as in previous years. These records, together with a number furnished by the New England section of the Weather Bureau, give quite completely the amount and distribution of rainfall throughout our state. This data is given in Table 57.

In this table are given the amounts of rainfall for the growing season recorded at twenty different places throughout the state. The average of the records taken at these twenty places during the growing season, May to October inclusive, shows the rainfall to be 22.93 inches. The lightest rainfall was at New London where but 17.04 inches was recorded, and the greatest amount was 28.47 inches at Cream Hill. The amount recorded at Storrs was 19.24 inches. This is 2.85 inches less than the rainfall for the same period in 1903, and 1.67 inches less than the average for the past fifteen years.

Table 58 contains a summary of the rainfall for the growing season, May 1 to October 31, as recorded at twenty different places throughout the state for the fifteen seasons preceding that of 1904.

A study of this table shows the fact that the rainfall varied greatly at different parts of the state, frequently being less than half as much at some places as at others. It is also an interesting fact to note that certain sections normally receive a much smaller rainfall than certain other sections. This is especially marked in the case of New London. The average difference between the places receiving the largest and smallest rainfall is 12.38 inches for the fifteen years. The average rainfall, taking the state as a whole, is quite accurately represented by the 24.60 inches given as the average for the last column.

The mean temperature for the year was 44.8° , which is 2.2° lower than the average for the past sixteen years. This is the lowest mean temperature recorded at Storrs since the Station began in 1888. The year which approached most nearly to this was 1893, which had a mean temperature of 45.1° . The unusually low average for the year's temperature was brought about by the severe cold in January, February and March, the means for those three months being 18° , 19° and 34° respectively, while the averages for the past sixteen years for the same months are 25.7° , 25.2° and 36.9° . The extremely cold weather of the winter months was followed by continued cool weather throughout the year, there being only two months when the temperature rose to the normal for those months. May was 0.1° and July 0.6° above the average for the past sixteen years.

In spite of the fact that the season was cool, killing frosts did not occur in the spring later than usual. The dates at different parts of the state varied from April 20 at New Haven to May 3, at which date frost occurred at a number of places throughout the state. The first killing frosts in the fall occurred on September 21 and 22, covering the larger part of the state. New Haven and New London escaped frost until October 27 and 28. At Storrs the last killing frost in the spring occurred April 24, and the first one in the fall came with the general frost of September 22, giving a growing season of 150 days free from frosts. This is three days longer than the average for the preceding sixteen years.

TABLE 56.
Meteorological Observations for 1904.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	Mean.
Highest temperature, -	50	49	63	72	83	90	89	83	80	74	59	47	—	70.
Lowest temperature, -	—11	—4	3	21	34	41	46	46	29	21	9	—1	—	19.5
Mean temperature, -	18	19	34	43	60	63	69	66	60	48	36	22	—	44.8
Total precipitation, inches, -	4.55	2.80	3.31	6.40	1.96	2.53	1.85	6.00	4.71	2.19	1.47	2.42	40.19	—
No. days with .01 inch or more precipitation, -	13	8	11	9	6	9	5	7	3	3	2	5	81	—

TABLE 57.

Rainfall during Growing Season, May 1 to October 31, 1904.

LOCALITY.	OBSERVER.	INCHES PER MONTH.						Total in Inches.
		May.	June.	July.	August.	September.	October.	
Canton, - -	G. J. Case, - -	2.43	3.09	3.55	6.24	6.92	3.38	25.61
Clark's Falls, - -	E. D. Chapman, - -	2.89	7.71	1.41	6.61	2.74	—	—
Colchester, - -	S. P. Willard, - -	2.74	2.87	2.44	5.07	6.40	2.71	22.23
Cream Hill, - -	C. L. Gold, - -	4.28	3.52	6.15	3.89	7.92	2.71	28.47
Falls Village, - -	M. H. Dean, - -	4.49	3.78	6.04	2.98	7.44	2.98	27.71
Hartford, - -	Weather Bureau, - -	3.19	2.94	3.64	5.45	5.45	2.25	22.92
Hawleyville, - -	E. N. Hawley, - -	4.10	2.38	3.63	4.00	7.26	3.69	25.06
Lebanon, - -	E. A. Hoxie, - -	3.28	3.08	2.18	5.12	4.00	2.12	19.78
Madison, - -	J. D. Kelsey, - -	2.81	2.43	2.07	7.92	4.52	2.21	21.96
New Haven, - -	Weather Bureau, - -	2.94	2.46	2.08	6.27	4.96	2.21	20.92
New London, - -	T. C. Dillon, - -	2.22	2.14	1.69	4.03	5.00	1.96	17.04
N. Grosvenor Dale, - -	Grosvenor D. Co., - -	1.88	2.20	2.22	6.61	6.72	2.01	21.64
Norwalk, - -	G. C. Comstock, - -	1.87	3.19	2.82	8.45	4.46	2.29	23.08
Southington, - -	L. Andrews, - -	2.63	2.63	4.85	5.45	6.90	2.55	25.01
South Manchester, - -	K. B. Loomis, - -	2.68	2.28	2.30	3.99	4.28	2.09	17.62
Storrs, - -	Agr. Expt. Station, - -	1.96	2.53	1.85	6.00	4.71	2.19	19.24
Torrington, - -	Prof. E. H. Forbes, - -	3.02	3.62	4.97	5.82	7.11	2.59	27.13
Voluntown, - -	Rev. E. Dewhurst, - -	3.30	3.53	1.90	4.31	5.60	1.91	20.55
Waterbury, - -	N. J. Welton, - -	3.31	4.20	4.62	4.93	8.02	3.05	28.13
West Simsbury, - -	S. T. Stockwell, - -	2.16	2.46	3.47	5.29	5.29	2.90	21.57
Average, - -	—	2.91	3.15	3.19	5.42	5.79	2.52	22.93

TABLE 58.—*Summary of Rainfall for Growing Season, May 1 to October 31, for Twenty Places in Connecticut.*

YEAR.	Highest.	Place of Occurrence.	Lowest.	Place of Occurrence.	Avg. 20 Observers
1889, -	37.38	New Haven,	28.64	N. Woodstock,	32.41
1890, -	31.87	Canton, -	24.89	New London,	29.07
1891, -	23.11	Franklin, -	14.91	Waterbury, -	19.59
1892, -	29.06	Falls Village,	14.12	N. Franklin,	19.67
1893, -	28.70	Oxford, -	18.31	New London,	24.32
1894, -	24.35	New Hartford,	15.69	Lake Konomoc,	19.79
1895, -	25.66	Voluntown, -	17.01	Newington, -	21.63
1896, -	26.19	Falls Village,	16.99	New London,	22.30
1897, -	39.78	Southington,	23.46	New London,	30.84
1898, -	34.88	Voluntown, -	23.87	Winchester, -	29.54
1899, -	25.69	Canton, -	15.04	New Haven,	19.34
1900, -	31.08	Falls Village,	12.40	New Haven,	19.65
1901, -	33.11	Waterbury, -	16.20	New London,	27.80
1902, -	35.40	Cream Hill, -	17.23	New London,	27.21
1903, -	34.45	Hawleyville,	16.13	New London,	25.78
Average, -	30.71	—	18.33	—	24.60

TABLE 59.
Monthly Mean Temperature for Past 16 Years.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.
1888, -	-	-	-	-	-	65.3	66.4	67.3	57.1	43.8	39.7	39.0	-
1889, -	30.8	22.1	34.9	45.6	58.4	65.2	67.9	64.8	59.7	45.8	40.9	35.1	47.6
1890, -	32.0	31.7	30.8	44.7	54.9	63.3	67.5	66.0	59.5	47.6	37.9	23.4	46.6
1891, -	28.8	29.3	31.9	46.1	54.1	63.9	65.2	68.4	63.7	48.3	38.2	37.0	47.9
1892, -	25.5	26.9	29.9	44.9	53.6	67.0	69.2	67.4	59.1	48.5	37.6	25.5	46.3
1893, -	17.3	23.5	30.3	42.0	54.5	64.2	67.9	68.0	55.9	51.7	38.1	27.8	45.1
1894, -	27.7	23.0	38.6	44.7	56.4	66.0	70.9	65.8	63.0	50.6	34.1	28.2	47.4
1895, -	24.4	19.9	31.1	44.1	57.3	66.7	66.1	68.3	63.1	45.0	41.7	32.6	46.7
1896, -	21.8	26.3	28.5	47.5	59.9	63.2	69.6	68.5	59.9	47.2	43.5	20.8	46.9
1897, -	25.0	27.0	34.0	46.0	56.0	62.0	69.0	66.0	60.0	51.0	39.0	31.0	47.2
1898, -	25.0	28.0	40.0	42.0	54.0	64.0	70.0	69.0	63.0	52.0	38.0	29.0	47.8
1899, -	25.0	22.0	31.0	45.0	56.0	67.0	68.0	67.0	59.0	52.0	39.0	31.0	46.8
1900, -	27.0	26.0	30.0	46.0	55.0	66.0	71.0	69.0	64.0	54.0	41.0	29.0	48.2
1901, -	25.0	19.0	33.0	45.0	54.0	67.0	71.0	66.0	62.0	50.0	33.0	29.0	46.2
1902, -	24.0	25.0	41.0	46.0	55.0	64.0	68.0	66.0	59.0	48.0	44.0	23.0	46.8
1903, -	26.0	27.8	43.1	45.9	58.8	59.3	66.0	61.7	60.8	51.1	35.8	23.3	46.8
Average, -	26.7	26.2	36.9	45.0	55.9	64.6	68.4	66.8	60.6	49.2	38.8	28.9	47.0

TABLE 60.
Monthly Precipitation for the Past 16 Years.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
1888, -	-	-	-	-	-	2.10	1.93	4.97	8.45	6.35	4.94	5.28	-
1889, -	4.03	1.64	1.96	3.49	2.16	3.50	11.39	3.78	4.00	5.52	5.91	2.88	50.26
1890, -	2.66	3.28	6.12	3.15	6.33	2.79	2.81	4.26	7.19	5.25	0.82	4.21	48.87
1891, -	8.52	5.64	4.42	3.51	2.50	1.84	4.96	3.95	4.08	4.14	3.09	4.96	51.61
1892, -	4.91	1.60	3.00	0.70	5.60	2.77	3.25	5.20	1.40	1.09	5.41	1.35	36.28
1893, -	2.39	5.88	4.67	3.82	7.12	1.98	1.58	3.79	2.58	6.71	2.45	3.68	46.65
1894, -	2.24	3.13	1.18	2.67	3.58	0.59	2.09	2.37	3.01	4.16	4.00	4.31	33.33
1895, -	5.78	0.63	2.62	4.27	2.16	1.78	4.13	3.48	2.97	6.74	6.97	4.12	45.05
1896, -	1.60	7.10	4.86	0.80	2.72	1.78	3.22	2.71	7.03	3.60	2.49	2.67	40.58
1897, -	3.84	3.40	3.66	2.37	4.44	2.79	12.24	5.23	1.39	0.92	7.14	5.61	53.03
1898, -	4.70	4.03	3.09	4.44	3.81	2.48	6.24	5.87	2.22	6.18	6.11	1.96	51.13
1899, -	3.76	3.97	5.58	2.20	1.17	3.72	5.55	3.27	3.31	1.54	2.10	2.14	38.31
1900, -	3.42	7.31	6.43	2.67	4.91	4.32	2.76	2.03	2.27	3.21	6.79	2.22	48.64
1901, -	8.50	1.05	7.18	9.51	6.30	1.96	5.54	7.58	4.33	1.97	3.04	9.55	66.51
1902, -	2.53	5.11	6.35	3.81	1.73	3.25	7.48	2.17	7.05	5.68	1.10	5.86	52.12
1903, -	3.73	5.18	7.09	2.81	0.50	9.24	4.56	4.52	1.81	2.79	1.95	4.27	48.45
Average, -	4.17	3.93	4.55	3.35	3.67	2.93	4.98	4.07	3.94	4.12	4.03	4.07	47.43

TABLE 59.
Monthly Mean Temperature for Past 16 Years.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.
1888, -	—	—	—	—	—	65.3	66.4	67.3	57.1	43.8	39.7	30.0	—
1889, -	30.8	22.1	34.9	45.6	58.4	65.2	67.9	64.8	59.7	45.8	40.9	35.1	47.6
1890, -	32.0	31.7	30.8	44.7	54.9	63.3	67.5	66.0	59.5	47.6	37.9	23.4	46.6
1891, -	28.8	29.3	31.9	46.1	54.1	63.9	65.2	68.4	63.7	48.3	38.2	27.0	47.9
1892, -	25.5	26.9	29.9	44.9	53.6	67.0	69.2	67.4	59.1	48.5	37.6	25.5	46.3
1893, -	17.3	23.5	30.3	42.0	54.5	64.2	67.9	68.0	55.9	51.7	38.1	27.8	45.1
1894, -	27.7	23.0	38.6	44.7	56.4	66.0	70.9	65.8	63.0	50.6	34.1	28.2	47.4
1895, -	24.4	19.9	31.1	44.1	57.3	66.7	66.1	68.3	63.1	45.0	41.7	32.6	46.7
1896, -	21.8	26.3	28.5	47.5	59.9	63.2	69.6	68.5	59.9	47.2	43.5	26.8	46.9
1897, -	25.0	27.0	34.0	46.0	56.0	62.0	69.0	66.0	60.0	51.0	39.0	31.0	47.2
1898, -	25.0	28.0	40.0	42.0	54.0	64.0	70.0	69.0	63.0	52.0	38.0	29.0	47.8
1899, -	25.0	22.0	31.0	45.0	56.0	67.0	68.0	67.0	59.0	52.0	39.0	31.0	46.8
1900, -	27.0	26.0	30.0	46.0	55.0	66.0	71.0	69.0	64.0	54.0	41.0	29.0	48.2
1901, -	25.0	19.0	33.0	45.0	54.0	67.0	71.0	66.0	62.0	50.0	33.0	29.0	46.2
1902, -	24.0	25.0	41.0	46.0	55.0	64.0	66.0	66.0	59.0	48.0	44.0	23.0	46.8
1903, -	26.0	27.8	43.1	45.9	58.8	59.3	68.0	61.7	60.8	51.1	35.8	23.3	46.8
Average, -	26.7	26.2	36.9	45.0	55.9	64.6	68.4	66.8	60.6	49.2	38.8	28.9	47.0

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TABLE 60.
Monthly Precipitation for the Past 16 Years.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
1888, -	—	—	—	—	—	2.10	1.93	4.97	8.45	6.35	4.94	5.28	—
1889, -	4.03	1.64	1.96	3.49	2.16	3.50	11.39	3.78	4.00	5.52	5.91	2.88	50.26
1890, -	2.66	3.28	6.12	3.15	6.33	2.79	2.81	4.26	7.19	5.25	0.82	4.21	48.87
1891, -	8.52	5.64	4.42	3.51	2.50	1.84	4.96	3.95	4.08	4.14	3.09	4.96	51.61
1892, -	4.91	1.60	3.00	0.70	5.60	2.77	3.25	5.20	1.40	1.09	5.41	1.35	36.28
1893, -	2.39	5.88	4.67	3.82	7.12	1.98	1.58	3.79	2.58	6.71	2.45	3.68	46.65
1894, -	2.24	3.13	1.18	2.67	3.58	0.59	2.09	2.37	3.01	4.16	4.00	4.31	33.33
1895, -	5.78	0.63	2.62	4.27	2.16	1.78	4.13	3.48	2.97	6.74	6.97	4.12	45.65
1896, -	1.60	7.10	4.86	0.80	2.72	1.78	3.22	2.71	7.03	3.60	2.49	2.67	40.58
1897, -	3.84	3.40	3.66	2.37	4.44	2.79	12.24	5.23	1.39	0.92	7.14	5.61	53.03
1898, -	4.70	4.03	3.09	4.44	3.11	2.48	6.24	5.87	2.22	6.18	6.11	1.96	51.13
1899, -	3.76	3.97	5.58	2.20	1.17	3.72	5.55	3.27	3.31	1.54	2.10	2.14	38.31
1900, -	3.42	7.31	6.43	2.67	4.91	4.32	2.76	2.03	2.27	3.21	6.79	2.22	48.04
1901, -	8.50	1.95	7.18	9.51	6.30	1.96	5.54	7.58	4.33	1.97	3.04	9.55	66.51
1902, -	2.53	5.11	6.35	3.81	1.73	3.25	7.48	2.17	7.05	5.68	1.10	5.86	52.12
1903, -	3.73	5.18	7.09	2.81	0.50	9.24	4.56	4.52	1.81	2.79	1.95	4.27	48.45
Average, -	4.17	3.93	4.55	3.36	3.67	2.83	4.98	4.07	3.94	4.12	4.02	4.07	47.33

TABLE 61.

Growing Season for past 16 Years.

YEAR					Last Killing Frost, Spring	First Killing Frost, Fall.	Growing Season.
1888,	-	-	-	-	May 16	September 7	114 days
1889,	-	-	-	-	May 4	September 23	142 "
1890,	-	-	-	-	April 29	September 25	148 "
1891,	-	-	-	-	May 5	October 17	164 "
1892,	-	-	-	-	April 30	September 21	144 "
1893,	-	-	-	-	May 8	October 17	161 "
1894,	-	-	-	-	May 15	September 26	134 "
1895,	-	-	-	-	May 17	October 15	150 "
1896,	-	-	-	-	May 2	September 24	144 "
1897,	-	-	-	-	April 22	September 28	159 "
1898,	-	-	-	-	May 10	October 17	160 "
1899,	-	-	-	-	May 4	September 15	134 "
1900,	-	-	-	-	May 11	October 18	158 "
1901,	-	-	-	-	May 6	September 26	142 "
1902,	-	-	-	-	May 28	October 10	135 "
1903,	-	-	-	-	May 3	October 15	165 "
Average,	-	-	-	-	—	—	147 "

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OF

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FOR THE YEAR ENDING OCTOBER 31

1905

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FOR THE YEAR ENDING OCTOBER 31, 1905.

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* Till July, 1905. † From September, 1905. § From October, 1905.

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ANNOUNCEMENT.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION was established by an Act of the General Assembly approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

By subsequent legislative acts it is made the business of this station to analyze all the brands of commercial fertilizers sold in the state, as well as to examine commercial cattle feeds and articles used for human food or drink on sale in Connecticut, with reference to their adulterations. Provision is also made for the testing and marking by this station of all apparatus used in determining the price of milk and cream.

Through the state entomologist, a member of the station staff, the station is required to make regular inspections of nurseries, to visit and examine orchards, nurseries, fields, gardens, or storehouses, at the request of their owners, to advise regarding treatment for insect pests and to diffuse information on the subject.

Through the state forester, also a member of its staff, the station is required to manage the state forest.

In addition to the work of "scientific investigation and experiment" in the service of agriculture, to the work required under special statutes above described, and to the expert work required by the dairy commissioner's office, the station analyzes and tests fertilizers, cattle-foods, seeds, milk and other agricultural materials and products, identifies grasses, weeds, moulds, blights, mildews, useful or injurious insects, suggests methods of combating injurious fungus and insect pests, advises as to the planting, management and care of woodland, etc., and gives information on various subjects of agricultural science, for the use and advantage of the citizens of Connecticut.

The station does not make sanitary analyses of water, as that work has been undertaken by the State Board of Health.

The station makes analyses of fertilizers, feeds, and other products, tests seeds, etc., for the citizens of Connecticut, without charge, provided—

1. That the results are of use to the public and are free to publish.
2. That the samples are taken from stock now in the market, and in accordance with the station "Instructions for Sampling."
3. That the samples are fully described and retail prices given on the station "Forms of Description."
4. That it is physically possible for the station to do the work in a reasonable time.

Results of analysis or investigation that are of general interest are published in bulletins, of which copies are sent to every citizen of the state who applies for them, as far as the editions will permit. These results are summed up in the annual reports made to the Governor.

It is the wish of the Board of Control to make the station as widely useful as its resources will permit. Every Connecticut citizen who is concerned in agriculture, whether farmer, manufacturer, or dealer, has the right to apply to the station for any assistance that comes within its province to render, and the station will respond to all applications as far as lies in its power.

Instructions and forms for taking samples will be sent on application.

Parcels by express should be prepaid and marked with the name of the sender. Communications should be directed to the

AGRICULTURAL EXPERIMENT STATION, NEW HAVEN, CONN.

The station grounds, laboratories and office are at 123 Huntington street, between Whitney avenue and Prospect street, 1½ miles north of City Hall. Huntington street may be reached by the Mt. Carmel and Whitney avenue electric cars, which pass the railway station every twelve minutes.

The station has telephone connection and may be spoken from all parts of the state at all hours between 7.30 A. M. and 9.30 P. M.

VISITORS ARE ALWAYS WELCOME.

REPORT OF THE BOARD OF CONTROL

OF THE

CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

To His Excellency, Henry Roberts, Governor of Connecticut:

The Board of Control of the Connecticut Agricultural Experiment Station, as required by law, herewith respectfully submits its report for the year ending October 31, 1905.

The following changes have occurred in the station staff:

I. A. Andrew, chemist, resigned July 1, to assist in managing a farm.

J. L. Kreider, B.S., a graduate of Lebanon Valley College, who received the degree of M.A. from Yale University in 1905, began work as chemist on September 1.

At the same time E. M. East, M.S., joined the staff as agronomist. Mr. East was graduated at the Illinois State University in 1901, and since then has been on the staff of the Illinois Agricultural Station.

E. J. Shanley, Ph.B., a graduate of Yale University of the class of 1904, joined the staff as chemist on October 1 of this year.

In 1905, thirty-four firms and individuals have entered for sale in this state two hundred and seventy-five distinct brands of commercial fertilizers. During the spring Mr. Churchill visited eighty-eight towns and villages of the state and drew six hundred and one samples of fertilizers.

As required by law, all of these brands have been analyzed under Dr. Winton's direction, and besides them, other samples of fertilizers and manurial waste products, making the total number of fertilizer analyses six hundred.

The results of this work are waiting to be printed.

Under the provisions of the law regarding food products, Mr. Churchill visited twenty-two towns and villages and bought eight hundred and eleven samples of food products, which have been examined and the adulterated foods in all cases promptly reported to the dairy commissioner, with whom rests the enforcement of the law. Two hundred and seventy-one other

samples of food products from various sources have been analyzed, and for the dairy commissioner four hundred and forty-seven samples, making the total number of food products one thousand five hundred and twenty-nine. This work has been done in the analytical laboratory under Dr. Winton's direction. The large amount of microscopic study involved has been done wholly by Dr. Winton. The account of this work is also waiting to be printed.

Under the terms of the law regarding commercial feeds three hundred and thirty-seven analyses of feeding stuffs, collected in the fall of 1904, have been made and the results published in January in bulletin No. 147.

Two hundred and twenty-seven samples of feeding stuffs have been drawn within the last few weeks and, with others now being drawn, will be immediately analyzed for the information of dairymen and other feeders of stock.

Dr. Winton has done all of the microscopic work involved in the foregoing work and has directed the chemical work done by him and the assistant chemists, Messrs. Bailey and Andrew, and Miss Barber.

One article has been published by Dr. Winton in a scientific journal containing the results of research.

Dr. Winton also has in the press a volume of 700 pages, with the title "The Microscopy of Vegetable Foods." This work, the result of years of research, will be, we believe, the standard authority on the subject and indispensable to all who are engaged in the examination of human food products.

Under the provisions of the statute regulating the use of Babcock apparatus the station has tested one hundred and seventy pieces of graduated glassware and marked them as prescribed by law.

Four hundred and seventy-three samples of field and garden seeds have been tested with reference to their vitality, at the request of seedsmen and others. This has been done wholly by Mr. Churchill.

The study of the vegetable proteids, chiefly with reference to their decomposition products, has been continued by Dr. Osborne and Mr. Harris, who have been assisted, under a grant from the Carnegie Institution, by S. H. Clapp, B. A., Dr. R. D. Gilbert and Mr. A. C. Gilbert. The results of this year's work, so far as

ready, have been printed in four papers which appeared in the American Journal of Physiology.

Dr. Britton, the entomologist, with his assistants, has experimented with various spraying mixtures for the San José scale, having about six thousand trees under test. Special studies have been made of the insects attacking tobacco, of shade tree insects and of those concerned in pollinating the flowers of fruit trees.

As state entomologist, Dr. Britton has made forty-one nursery and fifty-seven orchard inspections.

Four articles have been published in scientific journals containing results of research by Dr. Britton and Mr. Viereck.

Dr. Clinton, botanist of the station, has made further critical studies of the peach scab fungus, the potato blight fungus, and the mildew of lima beans, of which the oospores have been discovered for the first time.

Collections and notes on little known or hitherto unreported diseases of plants of the state have been made.

Other work now in progress is a list of species collected by Dr. Clinton in Porto Rico in 1904, a report on the downy mildews of this state for the geological and natural history survey, and an extension of his monograph on the North American Ustilagineæ for the Flora of North America, prepared by the New York Botanical Garden.

The forester, Mr. Hawes, has practically finished the planting of the Lockwood field of fifty-five acres.

There has been bought from the Lockwood fund an additional tract of forty-five acres adjoining the Lockwood field and called the Clark field. About ten acres of this field have been planted with chestnut and eight acres with pine. These two fields, the property of the station, are used for experimental forestry work.

About one hundred acres have been added to the state's forest in Portland, making its total area one thousand acres, and improvement cutting has been done on about eighty acres of this tract. A tract of about two hundred and fifty acres has been bought for the state forest in the town of Union. This is in large part not wooded at present, but well suited to the growth of white pine which it is proposed to plant there.

Mr. Hawes with two assistants has also made a study of chestnut growth in woodlots and has established some experi-

mental areas in woodland for future study of forest growth. He has also advised and made working plans for a number of persons who desired to improve their woodland or to plant forest trees, and has answered all calls to address farmers on the improvement of farm woodlots.

The station, in coöperation with the Bureau of Plant Industry of the U. S. Department of Agriculture, has made a study of the improvement of the Sumatra, Havana and Broadleaf varieties of tobacco, by selection of seed and of plants for seeding and also by hybridizing. This work has been done at Granby, East Hartford and Poquonock, with assistance from growers in other places.

The experiments in fertilizing peach orchards and in growing alfalfa have been continued.

A canvass of the state was made last winter to find varieties of flint corn which seemed most promising for breeding, and during the summer seven such varieties have been tested together on the farm of Mr. G. A. Hopson, of Wallingford.

The report for the year 1904 is a volume of 482 pages, with 38 plates.

Five bulletins have been issued during the year aggregating 95 pages, with 25 plates and figures. There has also been issued a four page circular—Forestry for Farmers of Connecticut: An Offer of Assistance.

These have been distributed in editions of 12,000.

The number of letters and manuscript reports sent during the year by members of the staff has exceeded 5,400.

Members of the staff have also attended and made addresses at nineteen meetings of farmers within the state.

This board has held three meetings as follows: The annual meeting at Hartford, January 17th, and the regular spring and fall meetings at the Station on May 11th, and October 31st, respectively.

The executive committee has held two formal meetings besides informal conferences.

The treasurer's accounts for the state financial year have been duly examined by the state auditors and found correct.

All of which is respectfully submitted.

(Signed) WILLIAM H. BREWER, *Secretary*.

NEW HAVEN, CONN., November 1, 1905.

REPORT OF THE TREASURER.

E. H. JENKINS, in account with the Connecticut Agricultural Experiment Station for the fiscal year ending September 30, 1905.

RECEIPTS.

Balance on hand, October 1, 1904:		
Analysis Fees	\$809.99	
Insect Pest Fund	450.00	
		\$1,259.99
State Appropriation, Agriculture	\$10,000.00	
State Appropriation, Foods	2,500.00	
State Appropriation, Insect Pests	3,000.00	
United States Treasurer	7,500.00	
Analysis Fees	5,544.18	
Miscellaneous Receipts	90.11	
From the Lockwood Estate	7,949.30	
		36,583.59
		\$37,843.58

DISBURSEMENTS.

E. H. Jenkins, Salary	\$2,800.00
W. H. Brewer, "	100.00
V. E. Cole, "	800.00
L. M. Brautlecht, "	600.00
A. L. Winton, "	2,000.00
T. B. Osborne, "	1,800.00
I. F. Harris, "	1,000.00
E. Monroe Bailey, "	1,200.00
Kate Barber, "	611.52
I. A. Andrew, "	466.67
J. L. Kreider, "	50.00
W. E. Britton, "	1,500.00
G. P. Clinton, "	2,000.00
Austin F. Hawes, "	1,400.00
E. M. East, "	141.66
J. B. Olcott, "	800.00
H. Lange, "	800.00
Wm. Veitch, "	600.00
V. L. Churchill, "	660.00
Labor	1,522.15
Publications	959.38

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Postage	\$ 308.10	
Stationery	130.95	
Telephone and Telegraph.....	91.06	
Freight and Express.....	108.78	
Gas and Kerosene.....	262.90	
Coal	1,307.50	
Water	117.28	
Chemicals and Laboratory Supplies.....	1,303.66	
Agricultural and Horticultural Supplies.....	118.12	
Miscellaneous Supplies	214.88	
Fertilizers	271.93	
Feeding Stuffs	111.78	
Library and Periodicals.....	412.20	
Tools and Machinery.....	39.48	
Furniture and Fixtures.....	12.81	
Scientific Apparatus	221.44	
Traveling by the Board	195.32	
Traveling by the Staff	738.34	
Tobacco Experiment	1,385.62	
Fertilizer Sampling	164.44	
Food Sampling	314.40	
Insect Pest Appropriation to State Entomologist...	3,000.00	
Contingent	130.45	
Forestry and Lockwood Expenses.....	1,801.55	
New Buildings	2,128.00	
Betterments	167.26	
Repairs	453.31	
		\$37,322.94
Analysis Fees on hand, Sept. 30, 1905.....	\$ 70.64	
Insect Pest Funds on hand, Sept. 30, 1905.....	450.00	
		520.64
		<u>\$37,843.58</u>

NEW HAVEN, CONN., October 13, 1905.

THIS IS TO CERTIFY that we have examined the accounts of E. H. Jenkins, Treasurer of the Connecticut Agricultural Experiment Station, for the year ending September 30, 1905, compared said accounts with the vouchers therefor and found them correct.

JAMES P. BREE,
WILLIAM P. BAILEY,
Auditors of Public Accounts.

PART I.

Report on Commercial Fertilizers, 1905.

By E. H. JENKINS, *Director*, and A. L. WINTON, *Chemist in charge of the Analytical Laboratory*.

This station is required by statute to analyze yearly at least one sample of every commercial fertilizer which is offered for sale in the state. "Stable manure and the products of local manufacturers of less value than ten dollars per ton," are excepted.

The station is also required to publish these analyses yearly.

DUTIES OF MANUFACTURERS AND DEALERS.

The General Statutes, sections 4581 to 4590, inclusive, make the following requirements regarding commercial fertilizers:

1. The seller is responsible for affixing to every package sold, a label which shall correctly give the number of pounds in the package, name of the fertilizer, name and address of manufacturer, place of manufacture and a statement of composition, expressed in a way approved by this station.

2. He is also responsible for the payment to the station director, on or before May first, annually, of an analysis fee on every brand sold by him.

3. Before any brand of fertilizer is sold in the state, the agent or seller must file with the director of this station two certified copies of the statement named in 1, and a sealed glass jar containing not less than one pound of the fertilizer with an affidavit that it is a fair average sample.

The agent or seller is, however, free from the three obligations just stated if the manufacturer or importer fulfils them instead.

4. In any case the agent or seller must annually report to the director of this station his name, residence, address and the names of the fertilizers which he sells, with the names and addresses of the manufacturers or importers.

Copies of the statutes regarding fertilizers will be sent on application.

The statement of composition referred to in the statute must conform to the following requirements, which are approved by this station:—

A statement of the percentages of Nitrogen, Phosphoric Acid (P_2O_5) and Potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the percentage of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent of nitrogen" may likewise be stated.

The percentages of water-soluble and citrate-soluble phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of, water-soluble and citrate-soluble.

The percentage of insoluble phosphoric acid may be stated or omitted.

In case of bone, fish, tankage, dried meat, dried blood, etc., the statement of chemical composition may take account of the two ingredients, nitrogen and phosphoric acid.

For potash salts the percentage of potash (potassium oxide) should always be given: that of sulphate of potash or muriate of potash may also be stated.

The analysis fee for any brand will usually be ten, twenty or thirty dollars, according as one, two, or all three of the ingredients—nitrogen, phosphoric acid and potash—are contained or claimed to exist in the fertilizer.

OBSERVANCE OF THE FERTILIZER LAW.

During 1905 thirty-four individuals or firms have entered for sale in this state two hundred and seventy-five brands of fertilizers, viz:

Special manures for particular crops.....	122
Other nitrogenous superphosphates.....	93
Bone manures and "bone and potash".....	28
Fish, tankage, castor pomace and chemicals.....	32
Total	275

Here follows a list of manufacturers who have paid analysis fees as required by the fertilizer law and the names or brands of the fertilizers for which fees have been thus paid for the year ending May 1st, 1906:

<i>Firm.</i>	<i>Brand of Fertilizer.</i>
American Agricultural Chemical Co., The, 26 Broadway, N. Y. City.	Bradley's Complete Manure for Potatoes and Vegetables, Superphosphate, Potato Manure, Fertilizer, Corn Phosphate, Farmers New Method Fer- tilizer, Eclipse Phosphate, Complete Manure for Top Dressing Grass and Grain, Niagara Phosphate, Church's Fish and Potash, Crocker's Potato, Hop and Tobacco Fer- tilizer, Ammoniated Corn Phosphate, New Rival Fertilizer, Darling's Farm Favorite, Potato Manure, Dissolved Bone and Potash, Tobacco Grower, Blood, Bone and Potash, General Fertilizer, East India Potato Manure, A. A. Ammoniated Super- phosphate, Great Eastern Northern Corn Special, H. G. Vegetable, Vine and Tobacco Fertilizer, General, Packers' Union Gardeners' Complete Manure, Animal Corn Ferti- lizer, Potato Manure, Universal Fertilizer, Quinnipiac Market Garden Manure, Phosphate, Potato Manure, Phosphate, Corn Manure, Climax Phosphate, Read's Practical Potato Special, Standard Superphosphate, Vegetable and Vine Fertilizer, Wheeler's Corn Fertilizer, Potato Manure, Havana Tobacco Grower, Bermuda Onion Grower, Williams & Clark's Americus H. G. Spe- cial Fertilizer, Ammoniated Bone Super- phosphate, Potato Phosphate, Americus Potato Manure, Americus Corn Phosphate.

<i>Firm.</i>	<i>Brand of Fertilizer.</i>
American Agricultural Chemical Co., The,— <i>Continued.</i>	A. A. C. Co.'s H. G. Tobacco Manure. Complete Manure with 10% Potash, Grass and Lawn Top Dressing, Castor Pomace, Tobacco Starter and Grower, Dry Ground Fish, Fine Ground Bone, Nitrate of Soda, Muriate of Potash, Complete Tobacco Ma- nure, Southport XX Special, Grass and Oats Fertilizer. Acid Phosphate, H. G. Fertilizers with 10% Potash.
Armour Fertilizer Works, The, Balti- more, Md.	Grain Grower, High Grade Potato, All Soluble, Bone, Blood and Potash, Ammoniated Bone with Potash, Bone Meal, Complete Potato, Corn King, Market Garden.
Berkshire Fertilizer Co., Bridgeport, Conn.	Berkshire Complete Fertilizer, Potato and Vegetable Phos- phate, Ammoniated Bone Phosphate, Fine Ground Bone.
Boardman, F. E., Route 1, Middletown, Conn.	Boardman's Complete Fertilizer for Po- tatoes and General Crops.
Bohl, Valentine, Waterbury, Conn.	Self-Recommending Fertilizer, Complete Market Garden Fertilizer.
Bowker Fertilizer Co., 81 New Street, New York City.	Stockbridge Special Corn Manure. Tobacco Manure, Potato and Vegetable Ma- nure, Grass Top Dressing, Potato and Vegetable Fertilizer, Phosphate, Hill and Drill Phosphate, Farm and Garden Phosphate, or Am- moniated Bone, Fisherman's Brand Fish and Potash, Tobacco Starter, Ash Elements, Carbonates, Sure Crop Phosphate, Market Garden Fertilizer, Corn Phosphate,

<i>Firm.</i>	<i>Brand of Fertilizer.</i>
Bowker Fertilizer Co.,— <i>Continued.</i>	Early Potato Manure, Fine Ground Dry Fish, Fairfield Onion Fertilizer, Nitrate of Soda, Muriate of Potash, Fine Ground Bone, Complete Alkaline Tobacco Grower, Canada Hard Wood Ashes, Acid Phosphate, Square Brand Bone and Potash. Castor Pomace, Gloucester Fish and Potash, Middlesex Special, Potash Bone.
Buffalo Fertilizer Co., The, Station A., Buffalo, N. Y.	Fish Guano, Farmer's Choice, Ideal Wheat and Corn, Vegetable and Potato, Garden Truck, High Grade Manure, Bone Meal.
Clark, The Everett B. Co., Milford, Conn.	E. B. C. Special Mixture for General Use.
Coe, E. Frank, Co., 133-137 Front St., N. Y. City.	E. Frank Coe's H. G. Ammoniated Bone Superphosphate, Gold Brand Excelsior Guano, Red Brand Excelsior Guano, L. I. Market Garden Special, Columbian Corn Fertilizer, Columbian Potato Fertilizer, Celebrated Special Potato, [FP] Fish and Potash, XXX Pure Ground Bone, Tobacco and Onion Fertilizer. New Englander Corn Fertilizer, New Englander Potato Fertilizer, New Englander XXV Ammoniated Bone.
Connecticut Fat Rendering & Fertilizer Corporation, New Haven, Conn.	Tankage.
Connecticut Valley Orchard Co., The, Berlin, Conn.	C. V. O. Co.'s High Grade Special.
Cooper's Glue Factory, Peter, 13 Bur- ling-Slip, N. Y. City.	Pure Bone Dust.

<i>Firm.</i>	<i>Brand of Fertilizer.</i>
Dennis, George L., Stafford Springs, Conn.	Ground Bone.
Eldredge, T. H., 97 Water St., Norwich, Conn.	Eldredge's Special Fish and Potash Fertilizer, Superphosphate.
Frisbie, L. T. Co., The, Hartford, Conn.	Frisbie's Bone Meal.
James, Ernest L., Warrenville, Conn.	James' Bone Phosphate, Ground Bone.
Joynt, John, Lucknow, Ontario.	Canada Hard Wood Ashes.
Kelsey, E. R., Short Beach, Conn.	Bone, Fish and Potash.
Listers Agricultural Chemical Works, Newark, N. J.	Listers "Success" Fertilizer, "Celebrated" Ground Bone, Standard Potato Manure, Special Corn and Potato, 10% Potato, Standard Pure Bone Superphosphate of Lime.
MacCormack, William, Wolcott, Conn.	Mad River Strictly Pure Ground Bone.
Mapes, F. & P. G. Co., The, 143 Liberty St., N. Y. City.	Potato Manure, Tobacco Starter, Improved, Manure, Wrapper Brand, Fruit and Vine Manure, Economical Potato Manure, Vegetable Manure, or Complete Manure for Light Soils, Average Soil Complete Manure, Tobacco Ash Constituents, Corn Manure, Top Dresser, Improved, Full Strength, Half " " Complete Manure "A" Brand, Dissolved Bone, Cereal Brand, Seeding Down Manure.
National Fertilizer Co., Bridgeport, Conn.	Chittenden's Complete Fertilizer, Market Garden Fertilizer, Potato Phosphate, Ammoniated Bone Phosphate, Ground Bone, Universal Phosphate, Fish and Potash, H. G. Special Tobacco Fertilizer, Complete Tobacco Fertilizer, Plain Superphosphate, XXX Fish and Potash, Formula A.,

<i>Firm.</i>	<i>Brand of Fertilizer.</i>
National Fertilizer Co.,— <i>Continued.</i>	Chittenden's Soluble Bone and Potash, Special Potato Fertilizer, Dry Ground Fish, Special Tobacco with Car- bonate of Potash.
New England Fertilizer Co., The, 43 North Market St., Boston, Mass.	New England Corn and Grain Fertilizer, Perfect Tobacco Grower, Potato Fertilizer, Superphosphate, High Grade Potato Fer- tilizer, Ground Bone, Corn Phosphate.
Ohio Farmers Fertilizer Co., Columbus, Ohio.	General Crop Fish Guano, Ammoniated Bone and Potash, Potato and Tobacco Special.
Olds & Whipple, Hartford, Conn.	O. & W's. Complete Tobacco Fertilizer, Special Phosphate, Potato Fertilizer, " High Grade, Vegetable Potash, Home Mixture for Corn and Potatoes, Home Mixture for Grass.
Rogers & Hubbard Co., The, Middle- town, Conn.	Hubbard's Fertilizer for Oats and Top Dressing, Grass and Grain Fertilizer, Soluble Corn and General Crops Manure, Soluble Potato Manure, Tobacco " All Soils and All Crops Phosphate, Corn Phosphate, Potato " Pure Raw Knuckle Bone Flour, Strictly Pure Fine Bone, Market Garden Phosphate.
Rogers Manufacturing Co., The, Rock- fall, Conn.	Complete Potato and Vegetable, High Grade Corn and Onion Fertilizer, Fish and Potash Fertilizer, High Grade Soluble Tobacco, Oats and Top Dressing, Grass and Grain Fertilizer, Soluble Tobacco and Po- tato, Tobacco Starter, Pure Ground Bone, Knuckle Bone Flour, All Round Fertilizer.
Russia Cement Co., Gloucester, Mass.	Essex XXX Fish and Potash, Corn Fertilizer,

*Firm.*Russia Cement Co.,—*Continued.*Sanderson Fertilizer & Chemical Co.,
New Haven, Conn.Shay, C. M., Fertilizer Co., The, Groton,
Conn.Shoemaker, M. L. & Co., Philadelphia,
Pa.Swift's Lowell Fertilizer Co., 44 No.
Market St., Boston.*Brand of Fertilizer.*Essex Market Garden and Potato Ma-
nure,
A 1 Superphosphate,
Complete Manure for Corn, Grain
and Grass,
Complete Manure for Potatoes,
Roots and Vegetables,
Tobacco Starter,
Special Tobacco Manure,
Fine Bone Meal,
Dry Ground Fish,
Grass and Top Dressing Fer-
tilizer.Sanderson's Formula A.,
Potato Manure,
Superphosphate for Corn
and Grain,
Special with 10% Potash,
Formula B. for Tobacco,
Fine Ground Fish,
Bone,
Top Dressing,
Superphosphate with Pot-
ash,
Atlantic Coast Bone, Fish and Potash,
Muriate of Potash,
Nitrate of Soda,
Double Manure Salt.Shay's Potato Manure,
Corn Manure,
Pure Ground Bone,
Grass Fertilizer.Swift-Sure Bone Meal,
Superphosphate for General
Use,
Superphosphate for Pota-
toes,
Guano for Truck and
Onions.Swift's Lowell Bone Fertilizer,
Potato Phosphate,
Dissolved Bone and Pot-
ash,
Animal Brand,
Market Garden Manure,
Potato Manure,
Empress Brand,
Perfect Tobacco Grower,
Ground Bone,
Lawn Dressing,
Superior Fertilizer,
Special Grass Mixture,
Acid Phosphate,
Nitrate of Soda,
Muriate of Potash,
Tankage.

<i>Firm.</i>	<i>Brand of Fertilizer.</i>
Wilcox Fertilizer Works, The, Mystic, Conn.	Wilcox's Potato, Onion and Vegetable Manure, Potato Fertilizer, Complete Bone Superphosphate, Special Superphosphate, High Grade Fish and Potash, Fish and Potash, Grass Fertilizer, Nitrate of Soda, Dry Ground Fish, Pure Ground Bone, Acid Phosphate, Muriate of Potash.
Woodruff, S. D. & Sons, Orange, Conn.	Woodruff's Home Mixture.

The analyses which follow are chiefly useful as a guide in making purchases for the next year. Most of them are of brands which are offered year after year in Connecticut and the analyses serve to show whether these brands are maintaining their original quality.

The larger part of the year's supply of fertilizers is shipped into the state just before planting time, much of it after river navigation is opened. Many brands are not in market till the middle of April. Obviously these trade conditions make it absolutely impossible for the station to sample and analyze the two hundred and seventy-five brands of fertilizers sold in Connecticut and tabulate and publish the results in time to show the composition of all of them before they are bought and applied.

When new brands are offered, the station endeavors to analyze such brands at once and to distribute the report of the results as quickly and widely as possible. Farmers can aid greatly by calling the attention of the station promptly to new kinds of fertilizers which are offered for sale.

SAMPLING AND COLLECTION OF FERTILIZERS.

During April, May and June, Mr. V. L. Churchill, the sampling agent of this station, visited eighty-eight towns and villages in Connecticut to draw samples of commercial fertilizers for analysis. These places were distributed as follows:

Litchfield County	5
Hartford County	23
Tolland County	7
Windham County	8
New London County	12
Middlesex County	12
New Haven County	13
Fairfield County	8
	88

In these places six hundred and one samples were taken, representing all but four of the brands which have been entered for sale in this state.

The sampling agent could not find on sale Acid Phosphate, Nitrate of Soda and Muriate of Potash, sold by the Swift's Lowell Fertilizer Co., nor Ground Bone, sold by the National Fertilizer Co., and no samples of them were deposited by the manufacturers at the station. It was, therefore, impossible to make analyses of them.

With these exceptions an analysis has been made of every brand of fertilizer which has been entered at the station for sale in Connecticut.

When several samples of a single brand are drawn in different parts of the state, the analysis is usually performed, not on any single sample, but on a mixture made of equal weights of all of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of single samples.

The station agent is instructed in every case to open at least three packages of each brand for sampling, and, if the number of packages is very large, to take a portion from every tenth one, by means of a sampling tube which withdraws a section or core diagonally through the entire length of the bag or barrel.

As a rule, the station will not analyze samples taken from dealer's stock of less than one ton, from stock which has lain over from last season, or from stock which is improperly stored, as in bags lying on wet ground, or exposed to the weather, etc.

The station desires the coöperation of farmers, farmers' clubs and granges in calling attention to new brands of fertilizers, and in securing samples of all goods offered for sale. *All sam-*

ples must be drawn in strict accordance with the Station's Instructions for Sampling, and must also be properly certified. A copy of these instructions and blank certificates will be sent on application.

ANALYSES OF FERTILIZERS.

During the year 600 samples of commercial fertilizers and manurial waste-products have been analyzed. A classified list of them is given below and the results of their examination are given in detail in the following pages.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed, a copy of it is sent to the party who furnished the sample, and also to the manufacturer, in order that there may be opportunity for correction or protest, before the results are published.

CLASSIFICATION OF THE FERTILIZERS ANALYZED.

	No. of Samples.
<i>1. Containing Nitrogen as the chief valuable ingredient.</i>	
Nitrate of soda	9
Dried blood	2
Cotton seed meal	157
Castor pomace	4
Flax seed meal	2
<i>2. Containing Phosphoric Acid as the chief valuable ingredient.</i>	
Dissolved rock phosphate	5
Charred bone	1
<i>3. Containing Potash as the chief valuable ingredient.</i>	
Carbonate of potash	10
High grade sulphate of potash.....	4
Double sulphate of potash and magnesia.....	7
Muriate of potash	11
Kainit	1
Saltpeter waste	3
<i>4. Containing Nitrogen and Phosphoric Acid.</i>	
Bone manures	32
Slaughter-house tankage	13
Dry ground fish	12
<i>5. Mixed Fertilizers.</i>	
Superphosphates with potash salts	2
Nitrogenous superphosphates	113
Special manures	148
Home mixed fertilizers	11

6. *Miscellaneous Fertilizers and Manures.*

Vegetable potash	2
Cotton hull ashes	19
Wood ashes	21
Lime kiln ashes	2
Garbage ashes	1
Lime	2
South American guano	1
Sweepings from a fertilizer factory	1
Dust from wheat	1
Pulverized sheep manure	1
Rotted cotton seed compost	1
Dust from tobacco	1
Woolen carpet waste	1
Total number analyzed	600

DESCRIPTIONS AND ANALYSES OF FERTILIZERS.*

The samples referred to in the following pages were drawn by the station agent, unless the contrary is stated.

The analyses were made by the methods adopted by the Association of Official Agricultural Chemists and the results are always expressed in percentages, or parts per hundred by weight, of the material examined.

In order to avoid confusion, each sample, as it is received, is given a consecutive number, by which it is distinguished in the laboratory. As the numbers had become so large as to be somewhat unwieldy, the numbering was begun again at unity in 1900.

I. RAW MATERIALS CHIEFLY VALUABLE FOR NITROGEN,
NITRATE OF SODA OR SODIUM NITRATE.

Nitrate of Soda is mined in Chili and purified there before shipment. As offered in the Connecticut market it contains about 15.70 per cent. of nitrogen, equivalent to 95.3 per cent. of pure sodium nitrate.

Shipments differ somewhat in composition. The lowest percentage of nitrogen found in any sample this year is 15.36, equivalent to 93.25 per cent. of sodium nitrate.

* The analyses of fertilizers included in this chapter have been made by the chemists of the station, Messrs. Winton, Bailey, Andrew, and Miss Barber, with the help of Mr. Lange. The results have been tabulated and discussed by the director.

Nine samples from the Connecticut market have been analyzed, as follows:—

14120. Sampled and sent from Connecticut School for Boys, Meriden.

14119. Sold by American Agricultural Chemical Co., New York. Sampled from stock of J. G. Schwink, Meriden.

14380. Sampled from stock of the Wilcox Fertilizer Works, Mystic.

14144. Sold by Bowker Fertilizer Co., New York. Sampled from stock of E. E. Burwell, New Haven.

14179. Sampled from stock of S. D. Woodruff & Sons, Orange.

14151. Sold by American Agricultural Chemical Co., N. Y. Sampled from stock of Spencer Brothers, Suffield.

14160. Sampled from stock of Sanderson Fertilizer and Chemical Co., New Haven.

14118. Sold by Bowker Fertilizer Co., New York. Sampled from Bowker's Branch, Hartford.

13963. Sold by Bowker Fertilizer Co., New York. Sampled from stock of Andrew Ure, Highwood.

ANALYSES OF NITRATE OF SODA.

Station No.	14120	14119	14380	14144	14179	14151	14160	14118	13963
<i>Percentage amounts of</i>									
Nitrogen found	15.38	15.90	15.72	15.46	15.76	15.76	15.78	15.72	15.36
Nitrogen guaranteed	15.6	15.0	15.0	----	15.0	15.8	15.0	15.0	15.63
Cost per ton	\$49.75*	52.00	52.00	52.00	53.00	54.00	55.00	55.00	----
Nitrogen costs cents									
per pound	16.2	16.4	16.5	16.8	16.8	17.1	17.4	17.5	----

All the samples are of good quality, the percentage of nitrogen in them ranging from 15.36 to 15.90, with an average of 15.65 per cent.

The retail cost of nitrogen in them ranged from 16.4 to 17.5 cents per pound, the average being 16.9.

We believe that some farmers have undue prejudice against nitrate of soda because its nitrogen is in a form soluble in water and not held by the soil when leached with water. Nitrates will certainly wash down, and so out of sandy, leachy soils when heavy rains fall on them.

* Car lots.

The nitrates are also likely to decompose and the nitrogen to escape if they are applied along with much fresh stable manure. On the other hand, the nitrogen of nitrates acts more quickly than any other form and our experience has shown us the advantage of its use in many instances. Peach orchards in which the trees are past their best performance have been greatly benefited by a dressing of 350 pounds of nitrate per acre in the spring, before plowing. The trees made a vigorous growth of new wood the first season and a largely increased yield of fruit the year after.

Rye which has been partly winter-killed may be greatly benefited by a moderate amount of nitrate in the spring, 200 pounds or more per acre, where a dressing with nitrogen in organic forms would be of little use because the soil is too cold at that time to favor the proper decomposition of the fertilizer.

One of our growers of nursery stock, after years of experience, prefers nitrates to organic forms of nitrogen in his business.

On grass land nitrate is often said to be "flashy" and to affect only the first crop. A single observation carried on for ten years showed a decidedly better turf where nitrate was used annually than where sulphate of ammonia or cotton seed meal was applied in equivalent amount during the same time. The plots being on a pasture, no calculations could be made as to the profit or loss from the several applications.

DRIED BLOOD.

This is blood collected in slaughter houses, and dried by steam or hot air. It sometimes contains wool or hair in small amount and occasionally bone. It is, therefore, not at all uniform in composition, and for that reason the price varies with the actual composition. It is usually sold by the "unit of ammonia." A "unit" is one per cent., or 20 pounds of ammonia; but a "unit" of ammonia is about 16.5 pounds of nitrogen. Thus, if blood is quoted at \$2.64 per unit of ammonia, the price of a pound of nitrogen will be $\frac{264}{16.5}$ or 16 cents.

14145. Sold by Swift's Lowell Fertilizer Co., Boston. Sampled from stock of E. E. Burwell, New Haven.

13965. Sold by Bowker Fertilizer Co., N. Y. Sampled from stock of Andrew Ure, Highwood.

ANALYSES OF DRIED BLOOD.

Station No.	14145	13965
<i>Percentage amounts of</i>		
Nitrogen found	9.58	10.07
Nitrogen guaranteed	9.9	9.75
Cost per ton	\$42.00	....
Nitrogen costs cents per pound	21.9	....

There would seem to be no economy in paying 22 cents per pound for nitrogen in dried blood when it can be bought in form of nitrate and of cotton seed meal for 17 cents per pound.

COTTON SEED MEAL.

This material is of two kinds, which are known in trade respectively as undecorticated and decorticated. In their manufacture cotton seed is first ginned to remove most of the fiber, then passed through a "linter" to take off the short fiber or lint remaining, then through machines which break and separate the larger part of the hulls. The hulled seed is ground and the oil expressed. The ground cake from the presses is used as a cattle feed and fertilizer. Formerly the hulls were burned for fuel in the oil factories and the resulting ashes, which contained from 20 to 30 per cent. of potash, were used in this state as a tobacco fertilizer.

The hulls have, however, come into extensive use as a cattle feed at the South, and now sell for this purpose at prices which often forbid their use as a fuel.

According to the rules of the Interstate Cotton Seed Crushers' Association, which, as far as they concern chemical composition, are the same as those of the New York Produce Exchange, if a bargain is made for "choice" cotton seed meal, the seller must deliver meal containing at least 8 per cent. of ammonia, which is equivalent to 6.59 per cent. of nitrogen, or 41.19 per cent. of protein.

If a bargain is made for "prime" cotton seed *from Texas or the Mississippi Valley*, the delivered meal must contain at least the percentages named above. But if "Texas or the Mississippi Valley" is not specified in the order, the buyer may have to content himself with $7\frac{1}{2}$ per cent. of ammonia, equal to 6.18 per cent. nitrogen or 38.62 per cent. protein; which is very low grade.

In the table, pages 25 to 31, are analyses of 157 samples of cotton seed meal from stock bought chiefly, if not wholly, for use as a fertilizer.

The amount of cotton seed meal represented by all these samples is not known, but a part of them represent 1,820 tons, and the total amount is certainly considerably larger.

These figures show that in the small section of Hartford County, from which most of these samples came, more than \$50,000 was spent this year for cotton seed meal as a fertilizer.

It has been usual for dealers to guarantee 7.0 per cent. of nitrogen, but during the present year only about one-third of the samples have contained that amount. This has given rise to many complaints and claims for rebates on bills for meal delivered.

The percentage of nitrogen has varied with the month of delivery. Thus

6 lots, delivered in Dec., 1904, averaged 6.95 per cent. of nitrogen.					
28	"	"	Jan., 1905,	"	7.19 " "
22	"	"	Feb., "	"	7.02 " "
34	"	"	March, "	"	6.84 " "
51	"	"	April, "	"	6.83 " "
12	"	"	May, "	"	6.77 " "

The average percentages of phosphoric acid and potash in cotton seed meal are 3.15 and 1.90 respectively, which are valued together at \$4.42 per ton. To determine the cost of nitrogen, the above figure is subtracted from the ton price and the remainder after multiplying by 100 to reduce it to cents is divided by the number of pounds of nitrogen in a ton of meal.

Thus if a sample of meal contains 6.94 per cent. of nitrogen (which is equivalent to 138.8 pounds in the ton) and costs \$27.50 per ton, $27.50 - 4.42 = 23.08$. And $2,308$ divided by $138.8 = 16.6$, which is the cost of nitrogen per pound in cents.

The percentage of nitrogen ranges from 7.93 to 5.60, the latter amount being found in a sample containing an undue amount of hulls. The average percentage of nitrogen is 6.93, being 0.2 per cent. lower than last year.

The cost of nitrogen ranges from 14.2 to 20.6 cents per pound, the average cost being 16.36 cents, a shade less than in 1904.

Nineteen samples, 12 per cent. of the whole number, are not "choice" meal.

ANALYSES OF COTTON SEED MEAL.

Station No.	Dealer.	Purchased, Sampled or Sent by	Per cent. of Nitrogen.	Cost per ton.	Nitrogen costs per pound.
13925	Olds & Whipple, Hartford.	P. D. Kibbe, Hartford	7.93	\$27.00	14.2
13799	"	P. P. Hickey, Burnside	7.84	27.00	14.4
13816	"	W. H. Brewer, Silver Lane	7.72	27.00	14.6
13815	"	P. S. Brewer, "	7.73	27.00	14.6
13842	"	F. M. Hills, "	7.75	27.00	14.6
14176	L. O. Pomeroy, Suffield (Nat'l Fertilizer Co., Bridgeport).	Station agent	7.70	27.00	14.7
13850	Arthur Sikes, Suffield	W. C. Smith, Suffield, and others	7.64	27.25	14.9
14163	H. K. Brainard, Thompsonville (J. E. Soper & Co.).	G. A. Douglass, Thompsonville	7.18	25.90	15.0
13905	Arthur Sikes, Suffield	D. F. Brown and H. W. Alford, Windsor.	7.88	28.00	15.0
13843	"	C. A. Prout, Suffield, and others	7.58	27.25	15.1
14212	"	H. V. Griffin, East Granby	7.66	27.50	15.1
13849	"	F. O. Newton, Suffield, and others	7.80	28.00	15.1
14337	H. K. Brainard, Thompsonville	Wm. C. Viets, Suffield	7.07	25.90	15.2
13933	Arthur Sikes, Suffield	C. P. Viets, East Granby	7.24	26.50	15.2
14058	"	Jacob Lang, R. F. D., Windsor	7.77	28.00	15.2
13931	"	A. H. Brown, Windsor, and others	7.78	28.00	15.2
13922	"	A. N. Graves, Springfield, Mass.	7.20	26.50	15.3
13814	"	J. T. Hill, Suffield, and others	7.72	28.00	15.3
13845	"	H. Adams, "	7.73	28.00	15.3
14167	W. F. Fletcher, Southwick, Mass. (T. H. Bunch, Old Gold Brand)	L. C. Spring, Granby	7.08	26.25	15.4
14019	Spencer Bros., Suffield (Chapin & Co.)	S. R. Spencer, Suffield	7.17	26.50	15.4
13841	Arthur Sikes, Suffield	W. H. Prout, Suffield, and others	7.64	28.00	15.4
13844	"	A. C. Ludden, "	7.65	28.00	15.4
13946	F. M. Thompson, Warehouse Point.	W. H. Daly, Warehouse Point.	6.80	25.50	15.5

ANALYSES OF COTTON SEED MEAL.—Continued.

Station No.	Dealer.	Purchased, Sampled or Sent by	Per cent. of Nitrogen.	Cost per cent. per ton.	Nitrogen costs per cent. per pound.
14139	W. F. Fletcher, Southwick, Mass. (T. H. Bunch, Old Gold Brand)	L. R. Griffin, Granby	7.04	\$26.25	15.5
14169	Spencer Bros., Suffield (J. E. Soper & Co.)	Station agent (stock of R. Greer)	7.10	26.50	15.5
13902	Arthur Sikes, " "	Bissell, Graves Co., Suffield	7.14	26.50	15.5
14383	Newell St. John, Simsbury (Humphreys, Godwin & Co., Dixie Brand)	Station agent	7.30	27.00	15.5
13848	Arthur Sikes, Suffield, dark	Chas. H. Wells, Suffield	7.38	27.25	15.5
14450	Olds & Whipple, Hartford, dark	E. P. Brewer, Silver Lane	6.76	25.50	15.6
14165	W. F. Fletcher, Southwick, Mass. (T. H. Bunch, Old Gold Brand)	R. W. Griffin, Granby	6.98	26.25	15.6
14045	Spencer Bros., Suffield (J. E. Soper & Co.)	B. L. Root, Suffield	6.98	26.25	15.6
14244	H. K. Brainerd, Thompsonville	Seth Alden, Thompsonville	7.18	26.75	15.6
14262	Arthur Sikes, Suffield	H. V. Griffin, East Granby	7.41	27.50	15.6
14140	W. F. Fletcher, Southwick, Mass. (T. H. Bunch, Old Gold Brand)	L. R. Griffin, Granby	6.96	26.25	15.7
13450	Arthur Sikes, Suffield	Bissell, Graves Co., Suffield	7.02	26.50	15.7
13452	" "	" "	7.03	26.50	15.7
13911	" "	A. N. Graves, Springfield, Mass.	7.04	26.50	15.7
14279	" "	G. A. Harmon, Suffield, and others	7.33	27.50	15.7
14319	" "	Geo. A. Peckham, " "	7.35	27.50	15.7
14076	Geo. B. Robinson, New York (Sledge & Wells Co.)	E. N. Austin, " "	6.72	25.05	15.8
14168	W. F. Fletcher, Southwick, Mass. (T. H. Bunch, Old Gold Brand)	L. C. Spring, Granby	6.91	26.25	15.8
14046	Spencer Bros., Suffield (J. E. Soper & Co.)	B. L. Root, Suffield	6.91	26.25	15.8
14044	" "	" "	6.92	26.25	15.8
13449	Arthur Sikes, " "	Bissell, Graves Co., Suffield	6.97	26.50	15.8
14056	" "	Samuel Barr, R. F. D., Suffield	7.00	26.50	15.8

ANALYSES OF COTTON SEED MEAL.—Continued.

Station No.	Dealer.	Purchased, Sampled or Sent by	Per cent. of Nitrogen.	Cost per ton.	Nitrogen guaranteed per pound.
13851	Arthur Sikes, Suffield.	W. C. Knox, Suffield, and others	6.96	\$26.50	15.9
13928	Spencer Bros., Suffield (Chapin & Co.)	F. A. Scott,	7.10	27.00	15.9
14166	W. F. Fletcher, Southwick, Mass. (T. H. Bunch, Old Gold Brand)	R. W. Griffin, Granby	6.84	26.25	16.0
13451	Arthur Sikes, Suffield	Bissell, Graves Co., Suffield	6.88	26.50	16.0
14023	" " "	E. S. Seymour, Windsor Locks	6.88	26.50	16.0
14423	Broad Brook Lumber and Coal Co., Broad Brook, off color.	Dealers	6.88	26.50	16.0
14022	Arthur Sikes, Suffield	E. S. Seymour, Suffield	6.90	26.50	16.0
13453	" " "	J. F. Barnett, West Suffield	6.91	26.50	16.0
13454	" " "	J. E. Hastings,	6.91	26.50	16.0
13788	" " "	Bissell, Graves Co., Suffield	6.92	26.50	16.0
14334	E. N. Austin, Suffield (American Cotton Oil Co., Jackson, Tenn. Mill)	Station agent	7.03	26.90	16.0
14042	Arthur Sikes, Suffield	Samuel Orr, West Suffield	7.20	27.50	16.0
13806	" " "	F. F. Ford, Suffield, and others	6.85	26.50	16.1
13895	" " "	J. B. Rose, West Suffield, and others	6.87	26.50	16.1
14014	S. D. Viets, Springfield, Mass. (Am'n Cotton Oil Co., Texarkana Mill)	J. A. DuBon, Poquonock	6.87	26.60	16.1
14245	A. Pouleur, Windsor	Chas. A. Huntington, Windsor	6.92	26.75	16.1
14335	E. N. Austin, Suffield (Am'n Cotton Oil Co., Jackson Mill)	Station agent	6.99	26.90	16.1
14041	Arthur Sikes, Suffield	C. K. & H. T. Hale, Gildersleeve	7.00	27.00	16.1
14407	C. K. Hale, Gildersleeve (T. H. Bunch, Old Gold Brand)	Station agent	7.00	27.00	16.1
14073	Spencer Bros., Suffield (Chapin & Co.)	S. R. Spencer, Suffield	7.15	27.50	16.1

ANALYSES OF COTTON SEED MEAL.—Continued.

Station No.	Dealer.	Purchased, Sampled or Sent by	Per cent. of Nitrogen.	Cost per ton.	Nitrogen costs cents per pound.
14011	Spencer Bros., Suffield	T. H. Hauser, Suffield	7.17	\$27.50	16.1
14057	" " (Chapin & Co., St. Louis)	Chas. T. Remington, R. F. D. 2, Suffield	6.80	26.50	16.2
13969	Arthur Sikes, " "	D. I. King, Suffield	6.81	26.50	16.2
14097	Latham & Chittenden, Granby (T. H. Bunch, Old Gold Brand)	Dealers	6.98	27.00	16.2
14174	Spencer Bros., Suffield (Chapin & Co., Green Diamond Brand)	Station agent (stock of Chas. Remington)	6.77	26.50	16.3
13810	Arthur Sikes, Suffield	Bissell, Graves Co., Suffield	6.78	26.50	16.3
13948	" " " "	J. F. Brockett, Suffield, and others	6.78	26.50	16.3
13809	" " " "	Bissell, Graves Co., Suffield	6.79	26.50	16.3
13789	" " " "	" " " "	6.79	26.50	16.3
14015	T. H. Bunch, Little Rock, Ark., Old Gold Brand	Indian Head Plantations, Tariffville.	6.91	27.00	16.3
14266	R. L. Forsyth, Granby (Hunter Bros. Milling Co.)	F. St. John, Granby	6.92	27.00	16.3
14246	Arthur Sikes, Suffield (T. H. Bunch, Old Gold Brand)	Station agent (stock of E. S. Hale, Portland)	6.94	27.00	16.3
14074	Spencer Bros., Suffield (Chapin & Co.)	B. L. Root, Suffield	7.06	27.50	16.3
13891	Olds & Whipple, Hartford (Am'n Cotton Oil Co.)	E. P. Brewer, Silver Lane	6.81	26.75	16.4
14000	" " " "	A. E. Holcomb, Windsor	6.88	27.00	16.4
13980	Arthur Sikes, Suffield	Thomas Devine and O. E. Pitcher, Suffield	6.88	27.00	16.4
13811	Spencer Bros., " (Chapin & Co.)	S. R. Spencer, Suffield	7.03	27.50	16.4
13904	" " " "	Edmund Halladay, Suffield	7.04	27.50	16.4
13898	" " " "	S. R. Spencer,	7.05	27.50	16.4
13947	Arthur Sikes " "	D. P. Johnson, East Granby	6.68	26.50	16.5
14013	" " " "	E. S. Seymour, Windsor Locks	6.68	26.50	16.5
14079	W. F. Fletcher, Southwick, Mass.	Edmund Halladay, Suffield	6.78	26.75	16.5

ANALYSES OF COTTON SEED MEAL.—Continued.

Station No.	Dealer.	Purchased, Sampled or Sent by	Per cent. Nitrogen.	Cost per ton.	Nitrogen costs per pound.
13840	Arthur Sikes, Suffield	D. Lavery, Windsor	6.98	\$27.50	16.5
13908	Spencer Bros., " (Chapin & Co.)	Fuller, Haskins & Halladay, Suffield	6.98	27.50	16.5
14171	" " " (J. E. Soper & Co.)	Station agent	6.98	27.50	16.5
13831	" " " (Chapin & Co.)	S. R. Spencer, Suffield	7.00	27.50	16.5
13927	" " " "	B. L. Root, Suffield	7.00	27.50	16.5
13906	Arthur Sikes	Carey Bros., and D. D. Marshall, Windsor	7.00	27.50	16.5
13829	Spencer Bros., " (Chapin & Co.)	Clinton Spencer, Suffield	7.01	27.50	16.5
13926	" " " "	A. A. Brown, " "	7.01	27.50	16.5
13923	Arthur Sikes, " "	A. N. Graves, Springfield, Mass.	6.65	26.50	16.6
14006	" " " "	E. S. Seymour, Suffield	6.66	26.50	16.6
14336	M. E. Thomson, Ellington (C. M. Cox & Co.)	Station agent (stock of E. F. Miller)	6.73	26.75	16.6
14077	Arthur Sikes, Suffield	James T. Cain, Suffield	6.81	27.00	16.6
13897	Spencer Bros., " (Chapin & Co.)	Daniel Barron, " "	6.95	27.50	16.6
13971	Arthur Sikes, " "	E. C. Holdridge, " and others	6.62	26.50	16.7
14066	" " " "	F. B. Hatheway and Geo. Phelps, Suffield	6.76	27.00	16.7
14078	Spencer Bros., Suffield (Am'n. Cotton Oil Co., Texarkana, Ark.)	Oscar J. Hazard, Suffield	6.89	27.50	16.7
14172	Spencer Bros., Suffield (Chapin & Co.)	Station agent (stock of Chas. Pomeroy)	6.90	27.50	16.7
13979	Arthur Sikes, " "	John Carson, Enfield, and others	6.91	27.50	16.7
13970	" " " "	James Gamble, Thompsonville, and others	6.92	27.50	16.7
14071	Spencer Bros., " (J. E. Soper & Co.)	Dealers	6.92	27.50	16.7
13955	American Cereal Co., Boston (Sledge & Wells Co., Star Brand)				
14003	Olds & Whipple, Hartford	Ackley, Hatch & Marsh, New Milford	7.06	28.00	16.7
14065	Arthur Sikes, Suffield	Clark Bros., Poquonock	6.74	27.00	16.8
14069	Spencer Bros., " (Chapin & Co.)	C. S. Fuller, Suffield, and others	6.85	27.50	16.8
		Dealers	6.87	27.50	16.8

ANALYSES OF COTTON SEED MEAL.—Continued.

Station No.	Dealer.	Purchased, Sampled or Sent by	Per cent. of Nitrogen.	Cost per ton.	Nitrogen costs cents per pound.
13924	Arthur Sikes, Suffield	A. N. Graves, Springfield, Mass.	6.54	\$26.50	16.9
14263	S. D. Viets & Co., Springfield, Mass.	Geo. A. Harmon, Suffield	6.64	26.85	16.9
14060	Arthur Sikes, Suffield	James H. Wilson, Poquonock	6.74	27.25	16.9
14020	Spencer Bros., " (J. E. Soper & Co.)	S. R. Spencer, Suffield	6.83	27.50	16.9
14175	" " (Chapin & Co.)	Station agent (stock of D. E. Cavanaugh)	6.83	27.50	16.9
13967	Arthur Sikes, " "	C. H. Wright, Suffield, and others	6.84	27.50	16.9
13981	Arthur Sikes, Suffield	Price G. Jones, Suffield, and others	6.84	27.50	16.9
14018	Spencer Bros., " (Chapin & Co.)	H. S. Ponroy " and others	6.81	27.50	16.9
14067	Arthur Sikes, " "	F. B. Hatheway, " and others	6.77	27.50	17.0
14016	Olds & Whipple, Hartford	T. K. Marcy, Poquonock	6.77	27.50	17.0
14170	Spencer Bros., Suffield (J. E. Soper & Co.)	Station agent	6.77	27.50	17.0
14021	Arthur Sikes, " "	James T. Cain, and D. McComb, Suffield	6.78	27.50	17.0
14137	" " "	Fred Thrall, Windsor	6.78	27.50	17.0
14063	Arthur Sikes, Suffield	W. E. Ford, Suffield, and others	6.80	27.50	17.0
14138	" " "	Fred Thrall, Windsor	6.80	27.50	17.0
14315	" " "	Harry P. Lane, Suffield	6.61	27.00	17.1
13954	John S. Wolfe Co., Pittsfield, Mass. (T. H. Bunch, Old Gold Brand)	Ackley, Hatch & Marsh, New Milford	6.90	28.00	17.1
13899	Arthur Sikes, Suffield	Bissell, Graves Co., Suffield	6.42	26.50	17.2
14067	" " "	Herman Weber and W. J. Wilson, Windsor	6.65	27.25	17.2
14070	Spencer Bros., " (Chapin & Co.)	Dealers	6.70	27.50	17.2
14318	Arthur Sikes, " "	A. G. Hinckley, Suffield, and others	6.71	27.50	17.2
13790	" " "	Bissell, Graves Co., Suffield	6.40	26.50	17.3
13932	" " "	O. E. Pitcher, " "	6.52	27.00	17.3
14317	Spencer Bros., " "	Joseph P. Graham, " "	6.53	27.00	17.3
13846	Arthur Sikes, " "	J. A. Davis, Suffield, and others	6.67	27.50	17.3

COTTON SEED MEAL.

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ANALYSES OF COTTON SEED MEAL.—*Concluded.*

Station No.	Dealer.	Purchased, Sampled or Sent by	Per cent. of Nitrogen.	Cost per ton.	Nitrogen cents per pound.
14072	Spencer Bros., Suffield (Chapin & Co.)	Dealers	6.67	\$27.50	17.3
12992	" " (American Cotton Oil Co., Texarkana, Ark.)	Dealers	6.68	27.50	17.3
14320	Arthur Sikes, Suffield	H. D. Sikes, Suffield, and others.	6.64	27.50	17.4
14505	C. A. Arnold, Broad Brook (Am'n. Cotton Oil Co., England, Ark.)	F. A. Hamilton, Warehouse Point	6.27	26.50	17.6
13892	Arthur Sikes, Suffield	A. N. Graves, Springfield, Mass.	6.29	26.50	17.6
14012	Charles D. Clark, Granby (Am'n. Cotton Oil Co., England, Ark.)	John B. Cannon, R. F. D., Granby	6.60	27.60	17.6
13972	H. K. Brainerd, Thompsonville (T. H. Bunch, Old Gold Brand)	Seth Alden, Thompsonville	6.31	26.75	17.7
14005	C. D. Clark, Granby (Am'n. Cotton Oil Co.)	Alfred H. Griffin, Granby	6.54	27.60	17.7
14004	" " "	" " "	6.50	27.60	17.8
14173	Spencer Bros., Suffield (Chapin & Co.)	Station agent (stock of S. O. Ranney)	6.63	28.00	17.8
14452	W. J. Cox, East Hartford (F. W. Brode & Co., Owl Brand)	W. G. & F. Comstock, East Hartford	6.63	28.00	17.8
14075	S. D. Viets, Springfield, Mass.	Eugene S. Clark, Poquonock	6.18	26.50	17.9
14228	G. M. White & Co., East Hartford	James P. Graham, Suffield	6.31	27.00	17.9
14099	Arthur Sikes, Suffield	Dealers	6.58	28.00	17.9
14064	J. H. Cressey & Co., Boston (W. A. Kaiser & Co., Memphis, Tenn.)	E. A. Russell, Suffield, and others	6.37	27.50	18.1
13999	John S. Wolfe Co., Pittsfield, Mass. (Hunter Bros.)	Ackley, Hatch & Marsh, New Milford	6.51	28.00	18.1
14043	W. J. Cox, Hockanum	" " "	6.47	28.00	18.2
14772	Arthur Sikes, Suffield	Willard E. Treat, Silver Lane	6.48	28.00	18.2
14316		C. C. Austin, Suffield	6.18	27.00	18.3
14211		Geo. E. Gompf, " and others	5.60	27.50	20.6

CASTOR POMACE.

This is the ground residue of castor beans from which castor-oil has been expressed or extracted. The nitrogen which it contains is readily available to plants, but the pomace is extremely poisonous to animals, which often eat it greedily when the opportunity offers.

Four samples have been analyzed this year, as follows:—

14557. Sold by the American Agricultural Chemical Co., New York, sampled and sent by Arthur Manning, Hillstown.

14150. Sold by American Agricultural Chemical Co., New York, sampled from stock of F. S. Bidwell & Co., Windsor Locks.

14478. Sold by Olds & Whipple, Hartford, sampled and sent by P. P. Hickey, Burnside.

14384. Sold by Bowker Fertilizer Co., New York, sampled from stock of Warner & Hardin, Glastonbury, and of H. L. Spear, Suffield.

ANALYSES OF CASTOR POMACE.

Station No.	14557	14150	14478	14384
<i>Percentage amounts of</i>				
Nitrogen found	5.01	4.70	4.89	4.18
Nitrogen guaranteed .....	....	4.53	....	4.12
Cost per ton	\$23.00	23.00	25.00	23.00
Nitrogen costs cents per pound..	20.4	21.8	23.0	24.5

The percentages of phosphoric acid and potash in castor pomace average 1.95 and 0.98 respectively. The cost of nitrogen is determined in each case by deducting \$2.54—the valuation of the phosphoric acid and potash—from the ton price, and dividing the remainder by the number of pounds of nitrogen in a ton of the pomace.

The nitrogen of castor pomace is more costly than that of any other material used at all commonly as a fertilizer. There is no reason to believe that it is worth, agriculturally, what it costs, from 20 to 24½ cents a pound.

FLAX SEED MEAL.

A single sample of flax seed, or linseed, meal, **14062**, sampled from stock of Olds & Whipple, Hartford, by Clark Brothers, Windsor, contained 5.88 per cent. of nitrogen and cost

\$29.00 per ton. Linseed meal also contains about 2.15 per cent. of phosphoric acid and 1.50 per cent of potash. Valuing these at 4 and 5 cents per pound respectively the nitrogen in this sample cost 21.9 cents. This is somewhat less expensive than the nitrogen of castor pomace and our experiments indicate is quite as good as a tobacco fertilizer.

II. RAW MATERIALS CHIEFLY VALUABLE FOR PHOSPHORIC ACID.

DISSOLVED ROCK PHOSPHATE OR ACID ROCK.

This material, made by treating various mineral phosphates with oil of vitriol, has been practically the only form in which water-soluble phosphoric acid could be bought during the past year.

The following analyses show the quality of the dissolved phosphate sold this year in this state.

14123. Sold by the American Agricultural Chemical Co., New York, from the stock of J. G. Schwink, Meriden.

14398. Sampled from stock of Wilcox Fertilizer Works, Mystic.

13967. Sold by Bowker Fertilizer Co., New York, sampled from stock of Andrew Ure, Highwood.

14180. Sold by the E. Frank Coe Co., New York, sampled from stock of S. D. Woodruff & Sons, Orange.

14124. Sold by National Fertilizer Co., Bridgeport, sampled from stock of the Connecticut School for Boys, Meriden.

ANALYSES OF DISSOLVED ROCK PHOSPHATE.

Station No.	14123	14398	13967	14180	14124
<i>Percentage amounts of</i>					
Water-soluble phosphoric acid	13.68	14.62	12.40	10.70	7.71
Citrate-soluble phosphoric acid . . .	2.21	1.82	2.54	2.88	6.22
Citrate-insoluble phosphoric acid..	0.45	0.77	1.52	4.33	1.31
Total phosphoric acid found	16.34	17.21	16.46	17.91	15.24
Total phosphoric acid guaranteed ..	15.0	....	16.0	....	15.0
Sum of water-soluble and citrate-soluble phosphoric acid found..	15.89	16.44	14.94	13.58	13.93
"Available phosphoric acid" guaranteed	14.0	15.0	11.0	14.0	14.0
Cost per ten	\$14.00	16.00	....	....	....
"Available phosphoric acid" costs cents per pound	4.3	4.8	....	....	....

The samples show the usual range of composition, the percentage of water-soluble phosphoric acid being exceptionally low in 14124.

It needs to be remembered that "available phosphoric acid" is purely a trade name for the sum of the water-soluble and citrate-soluble phosphoric acid and has no necessary connection with the actual availability of the phosphoric acid to crops. Water-soluble phosphoric acid is comparatively readily available to plants. When applied to the soil it soon becomes insoluble in water, but exists for a time at least in forms which are easily decomposed and absorbed by the action of the plant roots. This is not by any means equally true of all forms of citrate-soluble phosphoric acid. Some of them are, probably, about as quickly and perfectly "available," in the agricultural sense, as water-soluble phosphates, while others are, by comparison, quite "unavailable" and there is no means, at present known, for determining this difference in the laboratory.

The method of citrate extraction was devised for, and is strictly applicable only to, the determination of that part of the phosphoric acid in a plain superphosphate ("acid phosphate," or dissolved rock phosphate) which had been at first dissolved by sulphuric acid but by further chemical reactions has become insoluble in water. It was formerly called "backgone" or "reverted" phosphoric acid.

But when this method is applied to such mixed fertilizers as are now in the trade, containing bone, tankage and sometimes iron and aluminum phosphates, citrate-solution dissolves much phosphate which has not been made more soluble by the manufacture than it was originally, and some of which cannot be considered as readily "available" to crops.

While "available" phosphoric acid has cost 4½ cents or more per pound at retail, it has been freely bought in mixed car lots for 3½ cents.

CHARRED BONE

A sample of this material, No. 15123, from a hardware factory, is a refuse consisting of ground bone which has been roasted without access of air. It contains 5.18 per cent. of sand, 3.47 per cent of charcoal and 36.26 per cent. of phosphoric acid. Experience shows that the phosphoric acid of this char

or bone black is very inert in the soil and the material is of little value to apply in its present state. An excellent superphosphate can be made from it, but not profitably, as a rule, on the farm.

III. RAW MATERIALS OF HIGH GRADE CONTAINING POTASH.

CARBONATE OF POTASH.

(ANALYSES ON PAGE 36.)

Commercial carbonate of potash has largely taken the place of cotton hull ashes as a source of potash for tobacco lands. It comes in casks, holding about one thousand pounds, and is a white granular solid which gathers moisture quickly if exposed to damp air and becomes noticeably moist and sticky. It must therefore be kept in tight, closed packages until needed for use. The lumps which are found in it are easily screened out and pulverized. No difficulty has been found in making, storing, or applying a mixture of cotton seed meal and carbonate of potash. If the mixture were kept over for a season, especially if it got damp, there is little doubt that it would cake badly in bags and liberate some nitrogen in form of ammonia from the meal. This tendency to absorb water makes the matter of proper sampling more than usually difficult.

The best way to sample is to bore into the middle of the cask with a long auger, quickly withdraw a sample, putting it at once into a can with a tight cover and later closing the hole in the cask with a bung cork.

The following ten analyses show the composition of the carbonate sold in this state:

14226. Sold by A. Klipstein & Co., 122 Pearl St., New York, sampled and sent by E. O. Marsh, New Milford.

14265. Sold by Klipstein, sampled and sent by John Sullivan, Suffield.

14213. Sold by Klipstein and sent by W. W. Thompson, Warehouse Point.

14313. Sold by Klipstein, sampled and sent by G. A. Douglass, Thompsonville.

14248. Sold by Bissell, Graves Co., Suffield, sampled and sent by O. E. Pitcher, Suffield.

14153. Sold by National Fertilizer Co., Bridgeport, sampled from stock of Chas. T. Remington, Suffield.

14247. Sold by Klipstein, sampled from stock of E. S. Hale, Portland.

14479. Sold by Klipstein, sampled from stock of P. P. Hickey, Burnside.

14312. Sold by Klipstein, sampled and sent by Herman Ude, Suffield.

13416. Sold by T. Sisson & Co., Hartford Sent by T. Sisson & Co.

ANALYSES OF CARBONATE OF POTASH.

Station No.....	14226	14265	14213	14313	14248	14153	14247	14479	14312	13416
<i>Percentage amounts of</i>										
Potash found.....	67.22	66.54	67.16	65.86	63.94	65.64	67.18	66.95	64.10	60.78
Potash guaranteed..	66.0	66.0	66.0	65.0	66.0	66.0	66.0	66.0	66.0	....
Chlorine	0.45	0.90	0.72	1.13	0.07	0.27	0.67	0.90	1.05	1.56
Sulphuric acid.....	none	trace	none	none	none	none	none	none	none	1.82
Water	1.10	1.10	1.27	1.53	6.60	3.80	1.40	1.80	4.92	....
Cost per ton.....	\$90.00	95.00	95.00	95.00	92.00	95.00	98.25	98.00	....	....
Potash costs cents per pound.....	6.7	7.1	7.1	7.2	7.2	7.2	7.3	7.3	....	....

PROBABLE COMPOSITION OF THE SAMPLES.

Potassium carbonate	97.80	95.92	97.18	94.46	93.73	95.80	97.31	96.52	92.03	82.99
Potassium chloride .	0.95	1.92	1.51	2.37	0.14	0.57	1.41	1.89	2.21	3.25
Potassium sulphate..	none	trace	none	none	none	none	none	none	none	3.96
Water	1.10	1.10	1.27	1.53	6.60	3.80	1.40	1.80	4.92	9.00
Insoluble in water..	none	0.14	none	none	none	none	none	none	none	....
	99.85	99.08	99.96	98.36	100.47	100.17	100.12	100.21	99.16	99.29

The differences between 100.00 and the footings in the last line of the table represent in each case the errors of analysis.

Excluding **13416**, which is obviously a lower grade article, of quite different composition, it is seen that the others are closely alike save that three of them contain more moisture than the others. This moisture may have gathered in the sample after it was drawn, as explained above, or may have been in the goods themselves. If stored in a damp place carbonate in the casks may draw moisture and in that case will weigh more than is shown by the invoice weight. In one case a single cask weighed 40 pounds more than the invoice weight, which would represent 4 per cent. of moisture. In this case,

while the *percentage* of potash was slightly below guaranty, the total number of pounds of potash delivered was fully what the guaranty called for.

The cost of potash ranges from 6.7 to 7.3 cents per pound, the average being 7.1 cents, about 1.5 cents per pound less than in cotton hull ashes, as will appear on page 101.

HIGH GRADE SULPHATE OF POTASH.

(ANALYSES ON PAGES 38 AND 39.)

This chemical should contain over 88 per cent. of pure potassium sulphate (sulphate of potash), or about 49 per cent. of potassium oxide, a per cent. less than is contained in muriate, and should be nearly free from chlorine.

These four samples, whose analyses appear in the table, all contain more than the guaranteed percentage of potash and are of good quality.

Potash in this form has cost on the average 5.0 cents per pound.

DOUBLE SULPHATE OF POTASH AND MAGNESIA.

(ANALYSES ON PAGES 38 AND 39.)

This material is usually sold as "sulphate of potash" or "manure salt," on a guaranty of "48-50 per cent. sulphate," which is equivalent to 25.9-27.0 per cent. of potassium oxide. Besides some 46-50 per cent. of potassium sulphate, it contains over 30 per cent. of magnesium sulphate, chlorine equivalent to 3 per cent. of common salt, a little sodium and calcium sulphates, with varying quantities of moisture.

Seven samples of this potash salt have been analyzed this year. No. 14294 is stated by the sender to have been bought for \$45.00 per ton, the price of muriate. It is, however, double sulphate of potash and the cost of potash in it is therefore reckoned on the cost price of double sulphate, i. e. \$30.00 per ton.

The average cost of potash in this form has been 5.3 cents per pound, 0.3 cent higher than in high grade sulphate.

MURIATE OF POTASH.

(ANALYSIS ON PAGES 38 AND 39.)

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride), 15 per cent. or more of common salt (sodium chloride) and 4 per cent. or more of water.

POTASH SALTS. PERCENTAGE COMPOSITION AND

Station No.	Drawn from Stock in possession of	Sampled and sent by
<i>High Grade Sulphate of Potash:</i>		
14149	W. E. Burbank, Suffield, from National Fertilizer Co.	Station agent
14152	E. N. Austin, Suffield, from American Agricultural Chemical Co.	"
14143	E. E. Burwell, New Haven, from Swift's-Lowell Fertilizer Co.	"
14156	Spencer Bros., Suffield, from American Agricultural Chemical Co.	"
<i>Double Sulphate of Potash:</i>		
14249	Bissell, Graves Co., Suffield.	Oscar E. Pitcher, Suffield
14114	Conn. School for Boys, Meriden, from National Fertilizer Co.	Station agent
14155	E. N. Austin, Suffield, from American Agricultural Chemical Co.	"
14113	J. G. Schwink, Meriden, from American Agricultural Chemical Co.	"
14142	E. E. Burwell, New Haven, from Bowker Fertilizer Co.	"
14294	from Sanderson Fertilizer and Chemical Co.	C. M. Geer, Yantic
14161	Sanderson Fertilizer and Chemical Co., New Haven	Station agent
<i>Muriate of Potash:</i>		
13983	from E. Aspinall, N. Y.	A. C. Lake, R. D., Watertown
14116	Conn. School for Boys, Meriden, from National Fertilizer Co.	Station agent
14117	J. G. Schwink, Meriden, from American Agricultural Chemical Co.	"
14132	from S. D. Woodruff & Sons, Orange.	Harris J. Warner, Mt. Carmel Center
14314	from Sanderson Fertilizer and Chemical Co.	E. C. Warner, North Haven
14381	M. E. Thompson, Ellington, from Wilcox Fertilizer Works.	Station agent
14154	E. N. Austin, Suffield, from American Agricultural Chemical Co.	"
14162	Sanderson Fertilizer and Chemical Co., New Haven	"
14382	Bowker's Branch, Hartford, from Bowker Fertilizer Co.	"
14449	from Berkshire Fertilizer Co.	Newton M. Curtis, Sandy Hook
13964	Andrew Ure, Hamden, from Bowker Fertilizer Co.	Station agent
<i>Kainit:</i>		
14115	Conn. School for Boys, Meriden, from National Fertilizer Co.	Station agent

COST PER POUND OF POTASH.

Station No.	Percentages found.			Percentages guaranteed.		Cost per ton.	Potash costs cents per pound.
	Potash soluble in Water.	Equivalent Muriate.	Equivalent Sulphate.	Muriate.	Sulphate.		
14149	49.88	----	92.28	----	88.8	\$48.00	4.8
14152	49.28	----	91.17	----	88.8	49.00	5.0
14143	49.36	----	91.32	----	88.8	49.00	5.0
14156	49.69	----	91.93	----	88.8	53.00	5.3
14249	27.37	----	50.63	----	48.1	27.00	4.9
14114	27.33	----	50.56	----	50.0	27.25	5.0
14155	27.11	----	50.15	----	48.1	29.00	5.3
14113	26.49	----	49.01	----	46.3	28.00	5.3
14142	26.46	----	48.95	----	44.4	29.00	5.5
14294	26.74	----	49.47	----	----	30.00	5.6
14161	25.32	----	46.84	----	44.4	30.00	5.9
13983	55.02	86.93	----	82.7	----	43.55	4.0
14116	49.53	78.26	----	79.0	----	40.75	4.1*
14117	50.20	79.32	----	79.0	----	42.00	4.2
14132	52.84	83.49	----	----	----	45.00	4.3
14314	52.46	82.89	----	80.0	----	45.00	4.3
14381	50.83	80.31	----	79.0	----	44.00	4.3
14154	52.47	82.90	----	79.0	----	46.00	4.4
14162	51.68	81.65	----	79.0	----	45.00	4.4
14382	48.98	77.39	----	79.0	----	44.00	4.5
14449	55.62	87.88	----	80.0	----	45.00	4.0
13964	47.48	75.02	----	79.0	----	----	----
14115	12.49	19.73	----	19.0	----	11.75	4.7*

* Mixed car lots.

Of the eleven samples analyzed, two contain exceptionally high percentages of potash, over 55 per cent., and one an exceptionally low percentage, 47.5.

The average cost of potash has been 4.25 cents per pound.

KAINIT.

(ANALYSIS ON PAGES 38 AND 39.)

Kainit is less uniform in composition than the other potash salts. It contains from 11 to 13 per cent. of potash, more than that quantity of soda, and rather less magnesia. These "bases" are combined with chlorine and sulphuric acid. Unless "calined," it contains more water than either the sulphate or the muriate of potash. It is usually sold on a guaranty of 12 to 15 per cent. of potash, or 23 to 25 per cent. "sulphate of potash." It is not properly called, or claimed to be, a sulphate of potash, since it contains more than enough chlorine to combine with all the potash present, and there are sound reasons for believing that its potash exists chiefly as muriate and, to a much less extent, as sulphate. Its action and effects are unquestionably those of a muriate rather than of a sulphate.

The single sample analyzed this year cost \$11.75 per ton in a mixed car lot, the actual potash costing 4.7 cents per pound.

REFUSE SALT OR SALTPETER.

This material is a waste from the refining of saltpeter used in the manufacture of gun powder. It has no very constant composition, as the following analyses show.

13912. Sent by P. P. Hickey, Burnside. 13973 and 14227 were sent by Andrew Kingsbury, Rockville; the first sample being sent to him by the manufacturer, the second carefully drawn by him from a car load sent by the company.

	ANALYSES.		
<i>Percentage amounts of</i>	13912	13973	14227
Moisture	5.02	....	6.70
Sand and dirt	0.51	0.26	....
Nitrogen as nitrates	0.94	trace	1.65
Potash	7.24	35.50	27.76
Chlorine	52.02	50.12	40.67
Sulphuric acid	0.10	1.71	2.78
Soda and other matters by difference....	34.17	12.41	20.44
	100.00	100.00	100.00
Cost per ton			\$ 9.50
Valuation per ton			29.20

IV. RAW MATERIALS CONTAINING NITROGEN AND PHOSPHORIC ACID.

BONE MANURES.

The terms "Bone Dust," "Ground Bone," "Bone Meal" and "Bone" applied to fertilizers, sometimes signify material made from dry, clean and pure bones; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon and grease, and—if taken from garbage or ash heaps—with ashes or soil adhering; again they denote mixtures of bone, blood, meat and other slaughter-house refuse which have been cooked in steam tanks to recover grease, and are then dried and sometimes sold as "tankage"; or finally, they apply to bone from which a large share of the nitrogenous substance has been extracted in the glue manufacture. When they are in the same state of mechanical subdivision, the nitrogen of all these varieties of bone probably has about the same fertilizing value.

VALUATION OF FERTILIZERS IN GENERAL.

The following table contains a column headed "Valuation per ton."

The valuation of a fertilizer, as practiced at this station, consists in calculating the retail trade-value or cash-cost at freight centers (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

The trade value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the trade-value of the above-named ingredients a suitable margin for the expenses of manufacture and sale, and for the convenience or other advantage incidental to their use.

TRADE-VALUES OF FERTILIZER ELEMENTS FOR 1905.*

The average trade-values or retail costs in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash in raw materials and chemicals, as found in New England, New York and New Jersey markets during 1904, were as follows:

*Adopted at a conference of representatives of the Connecticut, Maine, Massachusetts, New Jersey, Rhode Island and Vermont stations, held in March, 1905.

	Cents per Pound.
Nitrogen in nitrates.....	17
in ammonia salts.....	17½
Organic nitrogen, in dry and fine-ground fish, meat and blood, and in mixed fertilizers.....	18½
in fine* bone and tankage.....	18
in coarse* bone and tankage.....	13
Phosphoric acid, water-soluble.....	4½
citrate-soluble†	4
of fine* ground bone and tankage.....	4
of coarse* bone and tankage.....	3
of cotton-seed meal, castor pomace, and ashes...	4
of mixed fertilizers, if insoluble in ammonium citrate†	2
Potash as high-grade sulphate in forms free from muriate (or chlorides)	5
as muriate	4¼
as carbonate	8

The foregoing are, as nearly as can be estimated, the prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those raw materials which are the regular source of supply. The valuations obtained by use of the above figures will be found to correspond fairly with the average retail prices, at the large markets, of standard raw materials, such as the following:

Sulphate of ammonia,	Carbonate of potash,
Nitrate of soda,	Sulphate of potash,
Dried blood,	Plain superphosphate,
Azotin,	Dry ground fish,
Ammonite,	Bone and tankage,
Muriate of potash,	Ground South Carolina rock.

VALUATION OF BONE AND TANKAGE

To obtain the valuation of ground bone the sample is sifted into two grades, that finer than $\frac{1}{32}$ inch "fine," and that coarser than $\frac{1}{16}$ inch, "coarse."

The nitrogen value of each grade is separately computed by multiplying the pounds of nitrogen per ton by the per cent. of each grade, multiplying one-tenth of that product by the trade value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing

* In this report "fine" as applied to bone and tankage, signifies smaller than $\frac{1}{32}$ inch; and "coarse," larger than $\frac{1}{16}$ inch.

† Dissolved from 2 grams of the fertilizer, previously extracted with pure water, by 100 cc. neutral solution of ammonium citrate, sp. gr. 1.09 in thirty minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or, "backgone" phosphoric acid.

up the separate values of each grade thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the valuation of the sample.

1. *Bone Manures Sampled by the Station agent.*

In the table on pages 44 and 45 are tabulated analyses of twenty-four samples.

GUARANTIES.

Eight of the samples drawn by the agent contain less nitrogen or phosphoric acid than is guaranteed, but in most cases when the percentage of one ingredient is below guaranty, that of the other is considerably above it.

The following brands have failed to meet their guaranty :

14346. Bohl's Self-Recommend' Fertilizer. Phosphoric acid found, 22.03, guaranteed, 23.0.

14357. Shay's Pure Ground Bone. Nitrogen found, 2.17, guaranteed 2.7. Phosphoric acid found, 29.62, guaranteed, 30.0.

14338. E. F. Coe Co.'s XXX Ground Bone. Nitrogen found, 2.30, guaranteed, 2.5.

14345. Berkshire Ground Bone. Phosphoric acid found, 18.84, guaranteed, 20.0.

14348. Buffalo Ground Bone. Nitrogen found, 2.37, guaranteed, 2.5.

14360. Swift's Lowell Ground Bone. Nitrogen found, 2.14, guaranteed, 2.5.

14362. Wilcox' Pure Ground Bone. Nitrogen found, 2.28, guaranteed, 2.5.

14364. Hubbard's Strictly Pure Fine Bone. Phosphoric acid found, 21.17, guaranteed, 22.0.

COST AND VALUATION.

The price printed in full-face in the column showing cost per ton is the one used in calculating the percentage difference.*

The average cost of the 24 samples drawn by the station is \$28.38 and the average valuation \$27.01, a fairly satisfactory agreement.

2. *Sampled by Purchasers and Others.*

In the table above referred to are analyses of eight samples drawn by others than the station agent.

* Percentage difference shows the percentage excess of the cost price over the average retail cost, at freight centers, of the nitrogen and phosphoric acid contained in the fertilizer.

PERCENTAGE COMPOSITION AND

Station No.	Name or Brand.	Manufacturer.
<i>Sampled by Station Agent.</i>		
14346	Self-Recommending Fertilizer.....	Valentine Bohl, Waterbury.....
14343	Ground Bone.....	Am'n Agricultural Chemical Co., N. Y.
14350	Pure Bone Dust.....	Peter Cooper's Glue Factory, N. Y.....
14353	Frisbie's Fine Bone Meal.....	The L. T. Frisbie Co., Hartford.....
14357	Shay's Pure Ground Bone.....	The C. M. Shay Fertilizer Co., Groton.
14352	Swift-Sure Bone Meal.....	M. L. Shoemaker & Co., Phila., Pa....
14543	New England Ground Bone.....	The New England Fertilizer Co., Boston
14338	E. F. Coe's XXX Ground Bone.....	E. Frank Coe Co., New York.....
14359	Essex Fine Bone Meal.....	Russia Cement Co., Gloucester, Mass.
14345	Ground Bone.....	Berkshire Fertilizer Co., Bridgeport...
14358	Sanderson's Fine Ground Bone.....	Sanderson Fertilizer and Chemical Co., New Haven.....
14347	Bowker's Fresh Ground Bone.....	Bowker Fertilizer Co., N. Y.....
14348	Buffalo Ground Bone.....	Buffalo Fertilizer Co., Buffalo, N. Y. ..
14361	Pure Fine Ground Bone.....	The Rogers Mfg. Co., Rockfall.....
14360	Ground Bone.....	Swift's Lowell Fertilizer Co., Boston...
14362	Wilcox' Pure Ground Bone.....	The Wilcox Fertilizer Works, Mystic ..
14342	Ground Bone.....	Am'n. Agricultural Chemical Co., N. Y.
14344	Armour's Bone Meal.....	Armour Fertilizer Works, Baltimore, Md.
14354	Hubbard's Pure Raw Knuckle Bone Flour.....	The Rogers & Hubbard Co., Middle- town.....
14363	Fine Knuckle Bone Flour.....	The Rogers Mfg. Co., Rockfall.....
14364	Hubbard's Strictly Pure Fine Bone.....	The Rogers & Hubbard Co., Middle- town.....
14351	Ground Bone.....	Geo. L. Dennis, Stafford Springs.....
14355	Mad River Pure Ground Bone.....	Wm. McCormack, Wolcott.....
14356	Lister's Celebrated Ground Bone.....	Lister's Agricultural Chemical Works, Newark, N. J.....
<i>Sampled by Purchasers and others.</i>		
14307	Fine Ground Bone.....	Sanderson Fertilizer and Chemical Co., New Haven.....
14477	"Swiftsure" Bone Meal.....	.....
14136	Cooper's Bone Meal.....	Peter Cooper's Glue Factory, N. Y.....
14308	Cooper's Bone.....	Peter Cooper's Glue Factory, N. Y.....
14009	Bone Meal.....	.....
14366	Swift's Lowell Ground Bone.....	Swift's Lowell Fertilizer Co., Boston...
14448	Berkshire Fine Ground Bone.....	Berkshire Fertilizer Co., Bridgeport....
14339	James' Ground Bone.....	E. L. James, Warrenville.....

VALUATION OF BONE MANURES.

Dealer.	Dealer's cash price per ton.	Valuation per ton.	Percentage difference between cost and valuation.	Chemical Analysis.				Mechanical Analyses.	
				Nitrogen.		Phosphoric acid.		Finer than 1-50 inch.	Coarser than 1-50 inch.
				Found.	Guar- anteed.	Found.	Guar- anteed.		
Manufacturer.....	\$25.00	\$30.33	17.6*	4.25	3.0	22.03	23.0	70	30
D. B. Wilcox & Co., Waterbury.....	25.00								
E. N. Austin, Suffield.....	22.50	24.38	7.7*	1.76	1.5	26.23	25.0	58	42
J. B. Parker, Poquonock.....	25.00	25.39	1.5*	1.20	0.9	30.64	26.7	53	47
Edward White, Rockville.....	29.00	28.56	1.5	4.85	3.3	19.70	18.0	47	53
Manufacturer.....	30.00	29.16	2.9	2.17	2.7	29.62	30.0	71	29
G. N. Williams Co., New Lon- don.....	28.00								
F. H. Roff, Guilford.....	35.00	35.44	3.0	5.84	4.1	23.41	20.0	59	41
J. P. Barstow & Co., Norwich.....	38.00								
	36.50								
A. R. Manning, Yantic.....	30.00	28.60	4.9	2.89	2.5	26.87	22.0	60	40
E. M. Jennings,† Green's Farms.....	30.00	28.29	6.0	2.30	2.5	27.76	19.0	72	28
Lightbourn & Pond Co., New Haven.....	30.00	28.21	6.3	4.48	3.3	20.70	18.0	48	52
Avery Bros., Norwich Town.....	30.00	27.42	9.4	4.33	2.5	18.84	20.0	60	40
Manufacturer.....	30.00								
R. H. Hall, East Hampton.....	30.00	26.48	9.5	3.45	2.5	23.13	20.0	45	55
C. D. Torrey, Putnam.....	28.00								
	29.00								
Bowker's Branch, Southport.....	27.00	25.37	10.4	2.92	2.5	22.26	18.0	60	40
J. A. Lewis & Co., Willimantic.....	29.00								
	28.00								
F. H. Gilbert, Jewett City.....	29.00	26.27	10.4	2.37	2.5	25.84	22.0	61	39
M. L. Loomis & Son, Westches- ter.....	29.00								
E. E. Burwell, New Haven.....	30.00	27.07	10.8	3.50	2.9	24.37	23.0	40	60
J. O. Fox & Co., Putnam.....	30.00	27.48	11.0	2.14	2.5	28.34	23.0	63	37
J. P. Barstow & Co., Norwich.....	31.00								
	30.50								
T. H. Eldredge, Norwich.....	30.00	26.03	13.3	2.28	2.5	26.23	22.0	58	42
Manufacturer.....	29.00								
	29.50								
J. A. Nichols, Danielson.....	32.00	26.43	13.5	2.50	2.5	26.12	22.0	55	45
C. Buckingham, Southport.....	28.00								
	30.00								
Gault Bros., Westport.....	30.00	26.27	14.2	2.74	2.5	24.00	24.0	63	37
W. B. Martin, Rockville.....	30.00								
H. W. Andrews, Wallingford.....	36.00	30.88	15.0	4.00	3.8	25.24	24.7	59	41
H. H. McKnight, Ellington.....	35.00								
	35.50								
E. E. Burwell, New Haven.....	32.00	30.36	15.3	4.00	3.8	25.66	24.0	50	50
Manufacturer.....	35.00								
H. H. McKnight, Ellington.....	31.00	25.83	18.1	3.84	2.9	21.17	22.0	39	61
John Bransfield, Portland.....	30.00								
	30.50								
Manufacturer.....	28.00	23.43	19.5	3.86	2.5	21.36	20.0	7	93
Manufacturer.....	32.00	23.17	38.1	3.93	3.0	20.79	20.0	6	94
J. C. Wilcoxson, Stratford.....	26.00	17.42	49.3	2.79	2.7	12.15	12.0	55	46
Wm. Sullivan, New Milford.....	26.00								
E. C. Warner, North Haven.....	28.00	29.34	4.6*	4.19	2.5	22.13	20.0	60	40
Olds & Whipple, Hartford.....	35.00	35.67	1.9*	5.93	---	22.32	---	66	34
A. Pouleux, Windsor.....	25.00	24.72	1.1	1.05	0.9	30.65	26.7	50	50
H. K. Brainard, Thompsonville.....	25.00	24.34	2.7	0.98	0.9	29.83	26.7	56	44
August Pouleux, Windsor.....	26.00	25.03	3.9	1.10	---	30.58	26.0	53	47
Zerah P. Beach,† Wallingford.....	28.00	26.53	5.5	2.14	2.5	27.44	23.0	59	41
Manufacturer.....	30.00	28.15	6.6	4.76	2.5	18.65	20.0	54	46
Manufacturer.....	29.00	22.85	26.9	3.96	---	20.53	---	3	97

PERCENTAGE COMPOSITION AND

Station No.	Manufacturer.	Sampled from stock of
	<i>Sampled by Station Agent.</i>	
14349	Conn. Fat Rend. and Fertz. Corp., New Haven	Manufacturer
14122	American Agricultural Chemical Co., New York	J. G. Schwink, Meriden...
14148	American Agricultural Chemical Co., New York	Spencer Bros., Suffield....
14146	Swift's Lowell Fertilizer Co., Boston	E. E. Burwell, New Haven
14341	American Agricultural Chemical Co., New York	E. N. Austin, Suffield.....
14340	American Agricultural Chemical Co., New York	" " " "
14181	Bought from a broker in New York	S. D. Woodruff, Orange ..
14121	National Fertilizer Co., Bridgeport	Conn. School for Boys, Meriden
13966	Bowker Fertilizer Co., New York	Andrew Ure, Highwood ..
	<i>Sampled by Purchaser.</i>	
13982	Unknown	A. C. Lake, Watertown....
14264	New England Fertilizer Co., Boston	Samuel T. Stockwell, West Simsbury
14135	Conn. Fat. Rend. & Fertz. Corp.	James Webb, New Haven.
14134	Unknown	Harris J. Warner, Mt. Carmel Center.....

SLAUGHTER-HOUSE TANKAGE.

After boiling or steaming meat scrap, bone and other slaughter-house waste, fat rises to the surface and is removed, the soup is run off and the settlings are dried and sold as tankage. Tankage has a very variable composition. In general, it contains more nitrogen and less phosphoric acid than bone.

In the table given above are nine analyses of this material made on samples drawn by the Station agent and four made on samples drawn by others.

In sample 14340, sold by the American Agricultural Chemical Co., was found nitrogen 6.90 per cent., guaranteed 7.4.

In sample 13966, sold by the Bowker Fertilizer Co., was found 11.86 per cent. of phosphoric acid, guaranteed 13.7.

VALUATION OF TANKAGE.

Station No.	Dealer's cash price per ton.	Valuation per ton.	Percentage difference between cost and valuation.	Chemical Analysis.				Mechanical Analysis.	
				Nitrogen.		Phosphoric acid.		Finer than 1-50 inch.	Coarser than 1-50 inch.
				Found.	Guaranteed.	Found.	Guaranteed.		
14349	\$20.00	\$26.23	23.8*	4.44	----	18.51	----	44	56
14122	27.00	28.62	5.7*	5.57	4.9	14.52	----	64	36
14148	30.00	29.69	1.0	5.53	4.9	16.29	----	63	37
14146	29.00	28.39	2.1	5.68	4.9	15.16	13.0	52	48
14341	29.00	25.54	13.5	4.95	4.9	16.21	----	36	64
14340	34.00	28.71	18.4	6.90	7.4	11.10	----	45	55
14181	----	35.44	----	7.91	4.9	13.77	----	62	38
14121	----	29.68	----	6.77	5.8	11.26	----	59	41
13966	----	25.76	----	5.48	4.9	11.86	13.7	56	44
13982	28.70	34.93	17.8*	8.24	5.8	12.63	11.1	55	45
14264	28.00	29.53	5.2*	5.16	5.8†	17.01	18.0†	69	31
14735	----	25.17	----	4.08	----	18.68	----	43	57
14134	----	34.37	----	8.13	----	12.78	----	52	48

* Valuation exceeds cost.

† Stated by purchaser to have been given by the selling agent. The tags sent were marked in pencil 6-7 ammonia, 30-35 bone phosphate, which are equivalent to 5.7 nitrogen and 13.7 phosphoric acid.

DRY GROUND FISH.

This is a by-product from the manufacture of fish oil, a process which removes from the fish little that is of value as a fertilizer.

The fresh fish are cooked by steam, pressed to remove the oil, and dried either in the air or, more commonly, in the large factories, by steam. The scrap is sometimes sprinkled with diluted oil of vitriol, to check putrefaction, whereby the bones are softened and to some extent dissolved. Twelve samples have been examined, as follows:—

14536. Sold by Wilcox Fertilizer Works, Mystic, sampled at factory, M. E. Thompson's, Ellington, and Spencer Bros., Suffield.

14133. Sold by Olds & Whipple, Hartford, sampled and sent by E. S. Seymour, Windsor Locks.

14476. Sold by American Agricultural Chemical Co., New York, sampled and sent by P. P. Hickey, Burnside.

14159. Sold by National Fertilizer Co., Bridgeport, stock of W. E. Burbank, Suffield.

14157. Sold by American Agricultural Chemical Co., stock of E. N. Austin, Suffield.

14396. Sold by Russia Cement Co., Gloucester, Mass., stock of J. & H. Woodford, Avon, and of W. J. Cox, East Hartford.

15879. Sold by American Agricultural Chemical Co., stock of E. N. Austin, Suffield.

14537. Sold by Bowker Fertilizer Co., New York, stock of Bowker's Branch, Hartford, and of Warner & Hardin, Glastonbury.

14397. Sold by Sanderson Fertilizer and Chemical Co., New Haven, stock of J. H. Hackett, Wapping.

14158. Sold by American Agricultural Chemical Co., stock of Spencer Bros., Suffield.

14010. Sold by American Agricultural Chemical Co., sampled and sent by T. H. Hauser, Suffield.

14164. Sold by Bowker Fertilizer Co., stock of E. E. Burwell, New Haven.

Guaranties.

Of the twelve samples, three have less nitrogen than is guaranteed; namely, American Agricultural Chemical Co., **15879** and **14010**, and Bowker's **14164**. Four have less phosphoric acid than is guaranteed; namely, American Agricultural Chemical Co.'s **14476**, **15879**, **14158** and **14010**, and Bowker's **14164**.

Cost and Valuation.

The average cost of the 12 samples is \$36.91 and the average valuation \$35.83. The valuations and selling prices are in most cases nearly alike, showing that dried fish has been, as in former years, a relatively cheap source of nitrogen and phosphoric acid.

PERCENTAGE COMPOSITION AND VALUATION OF DRY FISH.

	Wilcox's	Olds & Whipple's	Am'n Ag. Chem. Co.'s.	National Fertilizer Co.'s.	Am'n Ag. Chem. Co.'s.	Russia Cement Co.'s.	Am'n Ag. Chem. Co.'s.	Bowler's.	Sander-son's.	Am'n Ag. Chem. Co.'s.	Bowler's.
	14536	14133	14476	14159	14157	14396	15979	14537	14397	14010	14164
Nitrogen as ammonia-----	0.41	0.46	0.28	0.18	0.12	0.11	0.38	0.10	0.32	0.16	0.08
" organic-----	8.45	8.54	8.20	8.74	8.10	7.85	7.63	8.42	8.04	7.82	6.71
Total nitrogen found-----	8.86	9.00	8.48	8.92	8.22	7.96	8.01	8.52	8.36	7.98	6.79
" " guaranteed--	8.50	8.50	8.24	8.24	8.24	8.00	8.24	8.24	8.00	8.24	8.24
Water - soluble phosphoric acid-----	0.67	0.72	1.00	0.64	0.48	0.86	0.54	0.38	0.72	0.73	0.51
Citrate-soluble phosphoric acid-----	4.97	5.18	4.48	5.18	4.22	9.88	4.74	4.64	5.29	3.60	2.98
Citrate - insoluble phosphoric acid-----	1.38	1.43	1.24	1.48	2.27	4.16	1.12	1.39	1.58	1.06	0.73
Total phosphoric acid found-----	7.02	7.33	6.72	7.30	6.97	14.90	6.40	6.41	7.59	5.39	4.22
Total phosphoric acid guaranteed-----	6.00	6.00	7.00	----	7.00	11.00	7.00	6.00	6.00	7.00	6.00
Cost per ton-----	\$35.00	37.00	36.00	38.00	35.00	40.00	35.00	37.00	39.00	37.00	35.00
Valuation per ton-----	37.84	38.57	36.30	38.28	35.11	39.77	34.29	36.11	36.38	33.45	28.24
Percentage difference between cost and valuation--	7.5*	4.1*	0.8*	0.7*	0.3*	0.6	2.1	2.5	7.2	10.6	23.9

* Valuation exceeds cost.

IV. MIXED FERTILIZERS.

SUPERPHOSPHATES WITH POTASH SALTS.

14234. Sanderson's Superphosphate with Potash, made by the Sanderson Fertilizer and Chemical Co., New Haven, sampled from stock of manufacturer and stock of T. H. Eldredge, Norwich.

14470. Chittenden's Soluble Bone and Potash, made by National Fertilizer Co., Bridgeport, sampled from stock of H. A. Bugbee, Willimantic.

ANALYSES AND VALUATIONS.

	14234	14470
<i>Percentage amounts of</i>		
Water-soluble phosphoric acid	8.83	5.60
Citrate-soluble " "	2.43	4.51
Citrate-insoluble " "	0.34	3.25
"Available" phosphoric acid found	11.26	10.11
" " guaranteed	9.0	11.0
Water-soluble potash	2.77	2.08
Potash guaranteed	5.0	2.0
Cost per ton	\$20.00	25.00
Valuation per ton	13.60	11.72
Percentage difference between cost and valuation.....	47.1	113.3

NITROGENOUS SUPERPHOSPHATES AND GUANOS.

Here are included those mixed fertilizers containing nitrogen, phosphoric acid and, in most cases, potash, which are not designed by their manufacturers for use on any special crop.

"Special Manures" are noticed further on.

1 Samples Drawn by the Station Agent.

In the table of analyses, pages 56-71, are given analyses of ninety-seven samples belonging to this class, arranged according to the percentage difference between cost and valuation.

Analyses requiring Special Notice.

A sample of the Buffalo Fertilizer Co.'s Buffalo Garden Truck, No. **14327**, being a mixture of two samples drawn from stock of J. H. Atkins, Middletown, and W. H. H. Chappell, Chesterfield, respectively, was found to have the composition given on pages 60 and 61. The manufacturers protested that this analysis did not represent the average quality of the goods

and stated that the sulphate of potash used in this and another brand tended to separate from the other ingredients of the mixture, after being bagged. At their request another sample was drawn, No. 15122, from the stock of L. N. Dimmock, New London, the analysis of which appears on pages 58 and 59, and is quite unlike analysis No. 14327.

The station's sampling tools and method of sampling are specially designed to secure accuracy of sampling, as far as possible, even when the fertilizer in question is not an even mixture.

GUARANTIES.

Of the ninety-seven analyses of nitrogenous superphosphates given in the table, thirty-one, or nearly one-third of the whole number, are below the manufacturer's minimum guaranty in respect of one or more ingredients, and three are deficient in two ingredients. Nitrogen is deficient in eleven cases, phosphoric acid in ten and potash in thirteen.

In some cases the deficiency is but slight and is accompanied by a considerable excess of another ingredient, being explained by imperfect mixing of the ingredients at the factory.

The brands which thus fail to meet fully the claims made for them, as regards composition, are the following :

14409. Woodruff's Home Mixture. Potash found, 6.44, guaranteed, 8.0.

14191. Mapes' Top Dresser Improved. Nitrogen found, 9.86, guaranteed, 10.0.

14147. Swift's Dissolved Bone. Phosphoric acid found, 13.74, guaranteed, 14.0, "Available" phosphoric acid found, 11.66, guaranteed, 12.0.

14427. Coe's Red Brand Excelsior Guano. "Available" phosphoric acid found, 8.48, guaranteed, 9.0.

14416. Hubbard's Market Garden Phosphate. Phosphoric acid found, 9.80, guaranteed, 10.0.

14428. E. F. Coe's Gold Brand Excelsior Guano. Phosphoric acid found, 8.89, guaranteed, 10.0.

14489. American Agricultural Chemical Co.'s Southport XX Special. Nitrogen found, 3.96, guaranteed, 4.1. Potash found, 6.88, guaranteed, 7.0.

15122. Buffalo Garden Truck. Potash found, 6.52, guaranteed, 7.0.

14412. Buffalo High Grade Manure. Nitrogen found, 2.76, guaranteed, 3.3.

14429. Coe's Long Islander Market Garden Special. Phosphoric acid found, 8.96, guaranteed, 10.0. "Available" phosphoric acid found, 8.02, guaranteed, 8.5.

14198. Armour's Bone, Blood and Potash. Nitrogen found, 3.88, guaranteed, 4.1.

14472. Chittenden's Formula A. Nitrogen found, 3.13, guaranteed, 3.3.

14327. Buffalo Garden Truck. Nitrogen found, 2.80, guaranteed, 3.3. Potash found, 5.81, guaranteed, 7.0.

14411. Packers' Union Gardeners' Complete. Potash found, 9.48, guaranteed, 10.0.

14330. American Agricultural Chemical Co.'s Complete with 10 per cent. Potash. Nitrogen found, 3.16, guaranteed, 3.3.

14287. Chittenden's Complete. Phosphoric acid found, 9.79, guaranteed, 10.0.

14332. Williams & Clark's Americus H. G. Special. Nitrogen found, 3.13, guaranteed, 3.3.

14331. Darling's Dissolved Bone and Potash. Potash found, 9.81, guaranteed, 10.0.

14485. Swift's Lowell Market Garden. Nitrogen found, 3.98, guaranteed, 4.1.

14240. Buffalo Fertilizer Co.'s Farmers' Choice. Potash found, 4.55, guaranteed, 5.0.

14420. American Agricultural Chemical Co.'s H. G. Fertilizer with 10 per cent. Potash. Potash found, 9.17, guaranteed, 10.0.

14235. Russia Cement Co.'s Essex Fish and Potash. Potash found, 2.15, guaranteed, 2.3.

14391. Ohio Farmers' Fertilizer Co.'s Ammoniated Bone and Potash. Potash found, 3.28, guaranteed, 4.0.

14370. Lister's Success Fertilizer. Potash found, 1.84, guaranteed, 2.0.

14281. Sanderson's Special with 10 per cent. Potash. Nitrogen found, 1.98, guaranteed, 2.5.

14524. Quinnipiac Phosphate. Nitrogen found, 2.37, guaranteed, 2.5.

14298. Packer's Union Universal Fertilizer. Phosphoric acid found, 8.60, guaranteed, 9.0.

14510. Russia Cement Co.'s Essex A1 Superphosphate. "Available" phosphoric acid found, 6.58, guaranteed, 7.0. Potash found, 1.84, guaranteed, 2.0.

14518. Great Eastern General Fertilizer. Phosphoric acid found, 8.76, guaranteed, 9.0. "Available" phosphoric acid found, 7.43, guaranteed, 8.0.

14529. Bradley's Niagara Phosphate. "Available" phosphoric acid found, 6.83, guaranteed, 7.0.

14373. Ohio Farmers' Fertilizer Co.'s General Crop Fish Guano. Potash found, 0.70, guaranteed, 1.0.

COST AND VALUATION.

Cost.

The method used to ascertain the retail cash cost price of the superphosphates is as follows:

The sampling agents inquire and note the price at the time each sample is drawn. The analysis, when done, is reported to each dealer from whom a sample was taken, as well as to the manufacturer of the article, in order to give opportunity for explanation or correction as regards the price or the analysis itself. When the data thus gathered show a wide range of prices, further correspondence is required and the manufacturers are also consulted. In general an average or nearly average price forms the basis of comparison between cost and valuation. The price thus employed is printed in full-face type.

Valuation.

The valuation of a mixed fertilizer, as practiced at this station, consists in calculating the retail trade-value or cash-cost at freight centers (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

The schedule of trade-values is given on page 42. The organic nitrogen in mixed fertilizers is reckoned at the price of nitrogen in raw material of the best quality, 18½ cents per pound.

Citrate-insoluble Phosphoric Acid is rated at 2 cents per pound. Potash is rated at 4¼ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more potash present than will combine with the chlorine, then this excess of potash is reckoned at 5 cents per pound except in certain special cases, to be noted later, where carbonate of potash has been used in the mixture.

In most cases the valuation of the ingredients in superphosphates and specials falls below the retail price of these goods. The difference between the two figures represents the manufacturers' charges for converting raw materials into manufactured articles and selling them. The charges are for grinding and mixing, bagging or barreling, storage and transportation, commission to agents and dealers, long credits, interest on investment, bad debts and, finally, profits.

To obtain the valuation of a Fertilizer we multiply the pounds per ton of nitrogen, etc., by the trade-value per pound. We thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

Percentage difference given in the table shows the percentage excess of the cost price over the average retail cost, at freight centers, of the nitrogen, phosphoric acid and potash contained in the fertilizer.

This information helps the purchaser to estimate the comparative value of different brands and to determine whether it is better economy to buy the commercial mixed fertilizers, of which so many are now offered for sale, or to purchase and mix for himself the raw materials.

The average cost per ton of the ninety-seven nitrogenous superphosphates is \$30.79, the average valuation \$21.16, and the percentage difference 45.5.

Last year the corresponding averages were, cost \$31.07, valuation \$20.69, percentage difference 50.1.

The average composition and cost of nitrogenous superphosphates for a number of years have been as follows:—

PERCENTAGE COMPOSITION.

Year.	Nitrogen.	Available phosphoric acid.	Potash.	Cost per ton.
1905	2.56	10.02*	4.59	\$30.79
1904	2.68	10.02*	4.31	31.01
1903	2.75	8.12	4.53	30.39
1902	2.51	8.69	4.44	30.14
1901	2.52	8.77	4.48	28.43
1900	2.48	8.77	4.54	30.00

The following statement of the average amounts of nitrogen, phosphoric acid and potash which are purchasable for \$30.00 spent in factory mixed goods is based on their average retail prices and chemical composition, and not at all on the station's valuations.

PURCHASABLE FOR THIRTY DOLLARS.

	Nitrogen, pounds.	Phosphoric acid, pounds.	Potash, pounds.	Cost per ton.
In the first 12 samples in the table	72	185	113	\$32.33
" next 15 "	60	174	114	33.03
" " 12 "	60	167	104	32.29
" " 14 "	52	197	112	30.11
" " 14 "	41	228	69	29.78
" " 11 "	39	203	61	30.25
" " 14 "	31	203	58	29.40
" last 5 "	21	205	47	26.55

* Total phosphoric acid.

A study of the above table shows clearly the state of the trade at the present time in nitrogenous superphosphates.

1. Their prices bear no fixed relation to the amount of plant food in them, therefore no fixed relation to their value.

2. AS A RULE, fertilizers which sell at a low price are really the most costly if we regard the amount of plant food in them.

3. Some of the brands of fertilizers sold in Connecticut by reputable manufacturers and freely bought by some farmers, supply scarcely more than one-third of the plant food which can be bought for the same amount of money in other brands which are sold in the same places. That is, in buying these brands, the farmer is simply throwing away two-thirds of his purchase money.

There is no fraud in the matter. The composition of the low grade fertilizers corresponds fairly well with the guaranties, and if purchasers can be found who will pay for a ton of plant food as much as would suffice to purchase three tons, the seller is not breaking the law in taking advantage of their obtuseness.

2. Sampled by Purchasers and others.

On pages 70 and 71 are tabulated analyses of eleven samples of nitrogenous superphosphates which were sent to the station for analysis by interested persons. The station is not responsible for the sampling of these articles.

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	<i>Sampled by Station Agent:</i>				
14409	Woodruff's Home Mixture	S. D. Woodruff & Sons, Orange	R. E. Carey, Cheshire Manufacturer	\$28.00	\$26.04
14191	Mapes' Top Dresser, Improved, full strength	Mapes F. & P. G. Co., New York	Spencer Bros., Suffield	27.00	45.18
14147	Swift's Dissolved Bone	Swift's Lowell Fertilizer Co., Boston	Mapes' Branch, Hartford	51.00	
14495	Bone, Fish and Potash	E. R. Kelsey, Branford	E. E. Burwell, New Haven	49.00	
14304	Wilcox's H. G. Fish and Potash	Wilcox Fertilizer Works, Mystic	Loomis Bros., *Granby	26.00	22.97
			W. A. Howard, Woodstock	27.50	24.16
			J. W. Potter, R. F. D., Norwich	28.00	24.25
			Factory	27.00	
14302	C. V. O. Co's Complete H. G. Fertilizer	Conn. Valley Orchard Co., Berlin	Factory	28.00	22.71
14427	E. F. Coe's Red Brand Excelsior Guano	E. Frank Coe Co., N. Y.	A. L. Burdick, Westbrook	27.00	27.54
			W. H. Burr, † Westport	34.00	
				33.00	
14197	Quinnipiac Market Garden Manure	American Agricultural Chem. Co., N. Y.	C. Buckingham, Southport	33.50	26.71
			Gault Bros., Westport	32.00	
14416	Hubbard's Market Garden Phosphate	Rogers & Hubbard Co., Middletown	H. H. McKnight, Ellington	33.00	30.93
14428	E. F. Coe's Gold Brand Excelsior Guano	E. Frank Coe Co., N. Y.	Joseph Adams, † Westport	32.50	
			Chas. Mills, † Westport	29.00	24.20
			W. L. & S. T. Merwin, Milford	29.00	
				32.00	
				30.00	
14489	Southport XX Special	American Agricultural Chem. Co., N. Y.	Gault Bros., Westport	35.00	27.82
14196	Swift-Sure Superphosphate for General Use	M. L. Shoemaker & Co., Philadelphia	F. H. Rolf, Guilford	35.00	27.28
			James T. Kane, † Suffield		
			A. N. Clark, Milford	34.00	
14193	Mapes' Vegetable Manure or Complete for Light Soils	Mapes F. & P. G. Co., N. Y.	Spencer Bros., Suffield	34.50	32.40
			Mapes Branch, Hartford	42.00	
14284	Am'n Farmers' Market Garden Special	Armour Fertilizer Works, Baltimore	H. T. Child, Woodstock	41.00	26.74
			W. B. Martin, Rockville	33.00	
				35.00	
14547	Complete Manure with 10% Potash	American Agricultural Chem. Co., N. Y.	S. A. Flight, Highwood	34.00	27.39
				35.00	

* Stock of F. M. Colton.

† Not a dealer.

ANALYSES AND VALUATIONS.

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.							POTASH.		
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
14409	3.7	1.26	0.13	2.16	3.55	3.3	5.09	3.33	1.49	9.91	8.0	8.42	----	6.44	6.44	8.0
14191	8.5	9.56	0.30	0.00	9.86	10.0	1.94	5.26	1.24	8.44	8.0	7.20	----	1.61	5.41	4.0
14147	13.2	----	0.06	3.10	3.16	1.6	7.62	4.04	2.08	13.74	14.0	11.66	12.0	0.43	0.43	----
14495	13.8	----	0.50	2.64	3.14	2.5	4.24	2.36	0.24	6.84	5.0	6.60	4.0	0.57	6.06	4.0
14304	15.5	----	0.54	3.28	3.82	3.3	3.76	2.83	0.45	7.04	6.0	6.59	----	5.18	5.18	4.0
14302	18.9	----	0.52	2.18	2.70	2.5	8.00	1.82	1.39	11.21	11.0	9.82	9.0	4.23	4.23	4.0
14427	21.6	----	1.50	2.13	3.63	3.0	6.82	1.66	1.60	10.08	10.0	8.48	9.0	0.40	6.36	6.0
14197	21.7	0.43	1.17	1.80	3.40	3.3	6.56	2.59	1.07	10.22	9.0	9.15	8.0	7.16	7.16	7.0
14416	22.9	2.57	0.00	0.89	3.46	3.5	4.88	4.37	0.55	9.80	10.0	9.25	7.5	12.69	12.69	10.0
14428	24.0	0.00	0.76	2.11	2.87	2.4	5.60	1.29	2.00	8.89	10.0	6.89	8.0	0.73	6.97	6.0
14489	25.8	0.49	1.10	2.37	3.96	4.1	5.36	2.93	1.30	9.59	8.0	8.29	7.0	6.88	6.88	7.0
14196	26.5	0.88	---	2.02	2.90	2.6	7.93	4.82	0.94	13.69	----	12.75	----	0.70	5.54	4.0
14193	26.5	4.45	0.34	0.55	5.34	4.9	3.36	4.25	1.05	8.66	8.0	7.61	6.0	1.42	7.41	6.0
14284	27.2	0.35	0.28	2.73	3.36	3.3	6.62	2.85	0.70	10.17	10.0	9.47	8.0	7.00	7.00	7.0
14547	27.8	0.05	1.49	1.79	3.33	3.3	5.57	1.23	0.50	7.30	7.0	6.80	6.0	9.58	10.63	10.0

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton
	<i>Sampled by Station Agent:</i>				
15122*	Buffalo Garden Truck	Buffalo Fertilizer Co., Buffalo, N. Y.	L. N. Dimmock, New London	\$35.00	\$27.34
14494	Fish and Potash	Rogers Mfg. Co., Rockfall	R. E. Davis, Guilford	27.00	20.51
14412	Buffalo High Grade Manure	Buffalo Fertilizer Co., Buffalo, N. Y.	J. H. Lynch, Ellington	36.00	27.74
14469	Chittenden's XXX Fish and Potash ..	National Fertilizer Co., Bridgeport	J. W. Potter, Norwich	24.00	19.22
			W. H. Burr, † Westport	28.00	
			G. W. Eaton, Plainville	24.00	
				25.00	
14233	Atlantic Coast Bone, Fish and Potash ...	Sanderson Fertilizer & Chem. Co., New Haven	Factory	25.00	19.05
			Morse & Landon, Guilford	25.00	
			T. H. Eldredge, Norwich	25.00	
14418	Swift's Superior Fertilizer with 10% Potash	Swift's Lowell Fertilizer Co., Boston	D. W. Barnes, Windsor	40.00	30.47
14482	Mapes' Average Soil Complete Manure ..	Mapes F. & P. G. Co., N. Y.	Manchester Elevator Co., Manchester ..	35.00	26.44
			Mapes Branch, Hartford	35.00	
14431	Darling's Blood, Bone and Potash	American Agricultural Chem. Co., N. Y.	J. W. Gardner, Cromwell	37.00	27.95
14395	Mapes' Dissolved Bone	Mapes F. & P. G. Co., N. Y.	Manchester Elevator Co., Manchester ..	31.00	23.57
			Mapes' Branch, Hartford	31.00	
14429	E. Frank Coe's Long Islander Market Garden Special ..	E. Frank Coe Co., N. Y.	W. L. & S. T. Merwin, Milford	34.00	25.05
14256	Berkshire Complete Fertilizer	Berkshire Fertilizer Co., Bridgeport	Avery Bros., Norwich Town	34.00	23.99
			Johnson Bros., Jewett City	34.00	
			Factory	32.00	
14216	Wilcox's Complete Bone Superphosphate	Wilcox Fertilizer Works, Mystic	I. W. Dennison & Co., Mystic	28.00	21.32
			D. C. Spencer, Saybrook	29.00	
				28.50	
14198	Armour's Bone, Blood and Potash	Armour Fertilizer Works, Baltimore ..	H. M. Clayton, New Britain	38.00	28.42
			Brower & Malone, Norwich	38.00	

* See explanation, page 51.

† Not a dealer.

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.						POTASH.			
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
15122	28.0	0.63	---	2.57	3.20	3.3	6.51	3.75	1.16	11.42	9.0	10.26	8.0	1.00	6.52	7.0
14494	29.6	0.07	---	3.30	3.37	3.3	1.50	2.42	3.67	7.59	6.0	3.92	4.0	4.26	4.26	3.8
14412	29.8	---	---	2.76	2.76	3.3	5.36	2.75	1.68	9.79	8.0	8.11	7.0	0.70	9.94	10.0
14469	30.1	---	---	2.46	2.46	2.5	4.56	2.59	1.33	8.48	7.0	7.15	5.0	3.59	3.96	3.0
14233	31.2	---	0.30	1.98	2.28	1.7	1.60	4.47	2.37	8.44	6.0	6.07	4.0	5.53	5.53	4.0
14418	31.3	0.71	---	2.89	3.60	3.7	5.76	1.75	0.87	8.38	8.0	7.51	7.0	1.18	10.62	10.0
14482	32.4	3.40	0.22	0.56	4.18	4.1	4.08	3.31	1.12	8.51	8.0	7.39	7.0	1.05	5.43	5.0
14431	32.4	0.87	---	3.21	4.08	4.1	4.48	3.40	1.14	9.02	8.0	7.88	7.0	6.94	6.94	7.0
14395	32.6	---	0.30	2.60	2.90	2.1	5.87	8.89	0.77	15.53	---	14.76	12.0	---	---	---
14429	32.6	---	1.33	2.18	3.51	3.4	6.42	1.60	0.94	8.96	10.0	8.02	8.5	5.05	6.24	6.0
14256	33.4	0.52	0.43	1.95	2.90	2.5	5.48	3.27	2.23	10.98	10.0	8.75	8.0	5.94	5.94	6.0
14216	33.7	0.38	---	2.07	2.45	2.1	3.74	6.17	2.03	11.94	9.0	9.91	---	3.82	3.82	3.0
14198	33.7	0.15	1.55	2.18	3.88	4.1	7.04	2.27	0.76	10.07	9.0	9.31	8.0	7.00	7.00	7.0

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	<i>Sampled by Station Agent:</i>				
14472	Chittenden's Formula A	National Fertilizer Co., Bridgeport.....	G. W. Eaton, Plainville..... J. N. Lasbury, Broadbrook..... J. W. Potter, Norwich.....	\$35.00 31.00 32.00 32.75	\$24.47
14435	Market Garden Complete Fertilizer.....	Valentine Bohl, Waterbury	Factory	32.00	23.60
14275	Chittenden's Fish and Potash	National Fertilizer Co., Bridgeport.....	A. H. Cashen, Meriden..... W. E. Burbank, Suffield.....	32.00 29.00 30.50	22.42
14327*	Buffalo Garden Truck	Buffalo Fertilizer Co., Buffalo, N. Y.....	J. H. Atkins, R. F. D. 2, Middletown..... W. H. H. Chappell, R. F. D., Oakdale.....	33.00 35.00 34.00	24.92
14432	Bowker's Middlesex Special	Bowker Fertilizer Co., N. Y.	Southport Branch, Southport	25.00	18.15
14192	Sanderson's Formula A	Sanderson Fertilizer & Chemical Co., New Haven	Factory	35.00	25.24
14519	O. & W.'s Special Phosphate	Olds & Whipple, Hartford	Morse & Landon, Guilford.....	33.00	
14392	N. E. Superphosphate	New England Fertilizer Co., Boston.....	Factory	34.00	24.41
			A. R. Manning, Yantic	33.00	22.54
			J. A. Lewis & Co., Willimantic.....	31.00 32.00	
14217	Wilcox's Fish and Potash	Wilcox Fertilizer Works, Mystic.....	I. W. Dennison & Co., Mystic	25.00	19.00
			Olds & Whipple, Hartford	29.00	
			D. C. Spencer, Saybrook	26.00 26.75	
14374	Mapes' Top Dresser, Improved, one-half strength	Mapes F. & P. G. Co., N. Y.	Manchester Elevator Co., Manchester	31.00	22.75
			Mapes Branch, Hartford	32.00	
14411	Packers' Union Gardeners' Complete Manure	American Agricultural Chem. Co., N. Y.....	J. W. Gardner, Cromwell..... F. L. Mackey, Ellington.....	36.00 35.00 35.50	25.15

* See explanation, page 50.

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.							POTASH.		
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Murate.	Total.	Guaranteed.
14472	33.8	0.77	0.40	1.06	3.13	3.3	5.60	2.41	1.56	9.57	8.0	8.01	6.0	6.60	6.60	6.0
14435	35.1	1.63	---	1.85	3.48	3.0	none	3.75	7.35	11.10	10.0	3.75	---	6.30	6.30	6.0
14275	36.0	---	---	3.06	3.06	1.0	5.63	1.66	1.43	8.72	6.0	7.29	---	3.27	4.62	4.0
14327	36.4	0.20	---	2.60	2.80	3.3	6.51	2.82	1.90	11.23	9.0	9.33	8.0	0.49	5.81	7.0
14432	37.7	0.39	---	1.78	2.17	2.1	3.17	1.87	0.84	5.88	5.0	5.04	4.0	6.52	6.52	6.0
14192	38.7	1.06	---	2.21	3.27	3.3	4.10	4.38	2.20	10.68	8.0	8.48	6.0	6.30	6.33	6.0
14519	39.3	0.72	---	3.53	4.25	4.1	2.64	3.42	0.85	6.91	---	6.06	4.0	0.49	3.51	3.0
14392	40.1	---	---	2.62	2.62	2.5	6.96	3.34	1.34	11.64	10.0	10.30	9.0	4.33	4.33	4.0
14217	40.1	---	0.37	2.30	2.67	2.5	2.59	3.52	1.96	8.07	6.0	6.11	5.0	3.94	3.94	3.0
14374	40.7	4.47	--	0.48	4.95	4.9	0.91	1.93	1.70	4.54	4.0	2.84	---	0.64	2.83	2.0
14411	41.2	0.54	0.47	1.61	2.62	2.4	4.93	2.86	1.48	9.27	7.0	7.79	6.0	7.34	9.48	10.0

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	<i>Sampled by Station Agent:</i>				
14219	Bowker's Fisherman's Brand Fish and Potash	Bowker Fertilizer Co., N. Y.	G. F. Walter, Guilford Bowker's Branch, Hartford	\$25.00 25.00	\$17.66 •
14390	Bowker's Market Garden Fertilizer	Bowker Fertilizer Co., N. Y.	J. F. Silliman & Co., New Canaan Bowker's Branch, Hartford	36.00 35.00	24.73
14330	Complete Manure with 10% Potash	American Agricultural Chem. Co., N. Y.	L. M. Childs, North Grosvenordale D. B. Wilson & Co., Waterbury	37.00 38.00 37.50	26.46
14239	Buffalo Fish Guano	Buffalo Fertilizer Co., Buffalo, N. Y.	W. H. H. Chappell, R. F. D., Oakdale F. H. Gilbert, Jewett City	22.00 23.00 22.50	15.83
14506	Hubbard's All Soils, All Crops Phosphate	Rogers & Hubbard Co., Middletown	E. T. Clark, Milford	32.00	22.19
14287	Chittenden's Complete Fertilizer	National Fertilizer Co., Bridgeport	J. W. Potter, Norwich R. D. 3 G. A. & H. B. Williams, Silver Lane	36.00 38.00 37.00	25.66
14332	Williams & Clark's Americus H. G. Special	American Agricultural Chem. Co., N. Y.	W. H. H. Chappell, R. F. D., Oakdale T. B. Atwater, Plantsville	37.00 37.00	25.56
14331	Darling's Dissolved Bone and Potash	American Agricultural Chem. Co., N. Y.	Spencer Bros., Suffield	37.00	25.53
14517	E. F. Coe's [F.P.] Fish and Potash	E. Frank Coe Co., N. Y.	T. S. Loomis, Windsor A. L. Burdick, Westbrook	36.00 26.00	17.92
14269	Church's Fish and Potash	American Agricultural Chem. Co., N. Y.	J. G. Schwink, Meriden J. H. Paddock, Wallingford	25.00 26.00 25.50	17.33
14507	Bowker's Square Brand Bone and Potash	Bowker Fertilizer Co., N. Y.	Bishop & Lynes, Norwalk Bowker's Branch, Southport	32.00 25.00	16.95
14238	Mapes' Complete Manure, A Brand	Mapes F. & P. G. Co., N. Y.	Mapes' Branch, Hartford J. P. Barstow & Co., Norwich	34.00 36.00	23.05
14485	Swift's Lowell Market Garden Manure	Swift's Lowell Fertilizer Co., Boston	F. E. Weed & Co., New Canaan	40.00	27.01

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.						POTASH.			
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
I4219	41.4	0.96	---	1.54	2.50	2.5	3.84	1.46	0.61	5.91	5.0	5.30	4.0	4.53	4.53	4.0
I4390	41.5	0.78	---	1.84	2.62	2.5	4.88	2.04	0.76	7.68	7.0	6.92	6.0	10.53	10.53	10.0
I4330	41.6	0.89	0.49	1.78	3.16	3.3	4.99	2.19	0.85	8.03	7.0	7.18	6.0	10.07	10.07	10.0
I4239	42.1	----	---	1.08	1.08	0.8	6.16	3.54	1.75	11.45	----	9.70	7.0	0.20	2.79	2.0
I4506	44.2	1.50	---	0.95	2.45	2.3	7.28	5.15	0.80	13.23	12.0	12.43	10.0	3.03	3.03	3.0
I4287	44.2	0.85	0.29	2.12	3.26	3.3	6.48	2.35	0.96	9.79	10.0	8.83	8.00	6.85	6.85	6.0
I4332	44.8	0.99	0.42	1.72	3.13	3.3	5.79	3.21	1.12	10.12	9.0	9.00	8.0	7.21	7.21	7.0
I4331	44.9	0.31	1.10	1.52	2.93	2.5	6.62	0.61	0.54	7.77	7.0	7.23	6.0	9.81	9.81	10.0
I4517	45.1	----	0.12	1.81	1.93	2.0	5.28	2.99	3.22	11.49	7.0	8.27	6.0	2.79	2.79	2.0
I4269	47.1	----	---	2.16	2.16	2.1	5.47	1.99	2.10	9.56	7.0	7.46	6.0	2.34	2.34	2.0
I4507	47.2	0.08	---	1.79	1.87	1.7	2.93	5.20	3.46	11.59	7.0	8.13	6.0	2.25	2.25	2.0
I4238	47.5	1.41	0.38	1.03	2.82	2.5	4.48	6.51	2.19	13.18	12.0	10.99	10.0	3.03	3.45	2.5
I4485	48.1	0.96	0.13	2.89	3.98	4.1	5.60	2.16	0.98	8.74	8.0	7.76	7.0	6.40	6.40	6.0

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	<i>Sampled by Station Agent:</i>				
14252	Chittenden's Market Garden.....	National Fertilizer Co., Bridgeport....	L. O. Pomeroy, Suffield..... A. H. Cashen, Meriden.....	\$33.00 35.00 34.00	\$22.94
14240	Buffalo Farmers' Choice	Buffalo Fertilizer Co., Buffalo, N. Y.	F. H. Gilbert, Jewett City..... W. H. H. Chappell, R. F. D., Oakdale..	25.00 24.00 24.50	16.41
14523	Baker's A. A. Ammoniated Bone Superphosphate	American Agricultural Chem. Co., N. Y.	Edward White, Rockville.....	32.00	21.30
14203	Armour's All Soluble	Armour Fert. Works, Baltimore, Md.	Brower & Malone, Norwalk..... H. M. Clayton, New Britain.....	34.00 31.00 32.50	21.65
14188	Swift's Lowell Animal Brand	Swift's Lowell Fertilizer Co., Boston.....	Standard Feed Co., Bridgeport..... Spencer Bros., Suffield.....	33.00 34.00 33.50	22.15
14514	All Round Fertilizer.....	Rogers Mfg. Co., Rockfall	S. I. Munson, East Wallingford	28.00	15.23
14268	Berkshire Ammoniated Bone Phosphate.....	Berkshire Fertilizer Co., Bridgeport.....	Johnson Bros., Jewett City..... Factory	28.00 27.00	17.01
14513	Wilcox's Special Superphosphate	Wilcox Fertilizer Works, Mystic.....	Factory	24.00	15.55
14369	High Grade Ammoniated Bone Superphosphate	E. Frank Coe Co., N. Y.	J. P. Barstow, Norwich..... Warner & Hardin, Glastonbury.....	32.00 31.00 31.50	20.30
14502	Darling's Farm Favorite	American Agricultural Chem. Co., N. Y.	A. D. Zabriski, R. F. D. 3, Norwich..	28.00	15.00
14540	Standard Pure Bone Superphosphate of Lime	Lister's Agricultural Chemical Works, Newark, N. J.	A. I. Martin, Wallingford.....	32.00	20.57
14420	H. G. Fertilizer with 10% Potash.....	American Agricultural Chem. Co., N. Y.	Carlos Bradley, Ellington.....	36.50	23.37
14522	Williams & Clark's Americus Bone Superphosphate	American Agricultural Chem. Co., N. Y.	R. H. Hall, East Hampton.....	33.00	20.97
14235	Essex XXX Fish and Potash	Russia Cement Co., Gloucester, Mass.	Spencer Bros., Suffield..... A. R. Manning, Yantic.....	32.00 31.00 31.50	19.72

ANALYSES AND VALUATIONS—Continued.

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.							POTASH.		
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
14252	48.2	0.28	---	2.31	2.59	2.5	7.36	1.54	0.73	9.63	9.0	8.90	7.0	6.23	6.23	6.0
14240	49.3	----	----	0.80	0.80	0.8	4.70	4.23	3.35	12.28	9.0	8.93	8.0	0.35	4.55	5.0
14523	50.2	0.71	---	2.01	2.72	2.5	5.76	4.02	2.57	12.35	11.0	9.78	9.0	2.38	2.38	2.0
14203	50.3	----	1.20	1.46	2.66	2.5	6.45	2.96	1.08	10.49	9.0	9.41	8.0	4.02	4.02	4.0
14188	51.2	----	----	2.48	2.48	2.5	6.80	3.16	1.36	11.32	10.0	9.96	9.0	4.45	4.45	4.0
14514	53.1	----	----	2.06	2.06	1.7	4.24	4.10	3.75	12.09	10.0	8.34	8.0	2.43	2.43	2.0
14268	53.3	----	----	1.78	1.73	0.8	4.80	3.27	3.32	11.39	10.0	8.07	8.0	3.23	3.23	2.0
14513	54.3	----	----	1.47	1.47	1.0	4.32	4.28	2.35	10.95	9.0	8.60	----	2.19	2.19	1.5
14369	54.5	----	----	2.31	2.31	1.4	7.14	1.88	2.60	11.62	8.0	9.02	7.0	0.39	2.93	2.3
14502	54.8	0.41	0.15	1.58	2.14	2.1	4.72	3.19	2.13	10.04	10.0	7.91	8.0	3.14	3.14	3.0
14540	55.6	----	0.70	1.69	2.39	2.5	7.04	3.61	1.61	12.26	11.0	10.65	9.0	2.35	2.35	2.0
14420	56.2	0.66	---	1.74	2.40	2.4	4.67	2.78	1.19	8.64	7.0	7.45	6.0	9.17	9.17	10.0
4522	57.9	1.01	---	1.63	2.64	2.5	6.56	3.80	1.86	12.22	11.0	10.36	9.0	2.07	2.07	2.0
4235	59.7	0.35	---	1.89	2.24	2.1	4.77	4.83	3.90	13.50	12.0	9.60	9.0	2.15	2.15	2.3

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	<i>Sampled by Station Agent:</i>				
14391	Ammoniated Bone & Potash	Ohio Farmers' Fertilizer Co., Columbus, Ohio	R. B. Witter, Brooklyn	\$23.00	\$14.23
14270	Bradley's Farmers' New Method Fertilizer	American Agricultural Chem. Co., N. Y.	R. A. Sherman, Oneco Town	23.00	
			Avery Bros., Norwich	31.00	18.54
			D. L. Clark, Milford	29.00	
14271	Bradley's XL Superphosphate	American Agricultural Chem. Co., N. Y.		30.00	
			Avery Bros., Norwich Town	33.00	20.67
			Spencer Bros, Suffield	34.00	
14214	Swift's Lowell Dissolved Bone and Potash	Swift's Lowell Fertilizer Co., Boston	F. S. Bidwell & Co., Windsor Locks	33.50	
			A. L. Burdick, Westbrook	30.00	17.71
				27.50	
14204	Ammoniated Bone with Potash	Armour Fertilizer Works, Baltimore, Md.	Brower & Malone, Norwalk	28.75	
			H. M. Clayton, New Britain	34.00	18.95
				28.00	
14370	Lister's Success Fertilizer	Lister's Agricultural Chemical Works, Newark, N. J.	J. C. Wilcoxson, Stratford	31.00	
			J. A. Foster, Stafford Springs	26.00	16.47
				28.00	
14281	Sanderson's Special with 10% Potash	Sanderson Fertilizer & Chemical Co., New Haven	H. A. Bugbee, Willimantic	27.00	
			R. M. Goodale, Durham	35.00	21.51
				37.00	
14205	Bowker's Farm and Garden or Ammoniated Dissolved Bone	Bowker Fertilizer Co., N. Y.	E. B. Clark Co., Milford	36.00	
			Bishop & Lynes, Norwalk	24.00	16.94
				34.00	
14524	Quinnipiac Phosphate	American Agricultural Chem. Co., N. Y.	Young Bros. Co., Danielson	28.00	
			G. M. Williams Co., New London	31.00	19.50
				34.00	
14274	Chittenden's Universal Phosphate	National Fertilizer Co., Bridgeport	A. H. Cashen, Meriden	32.50	
			Gault Bros., Westport	24.00	14.94
				26.00	
15893	Swift's Dissolved Bone and Potash	Swift's Lowell Fertilizer Co., Boston, Mass.	A. S. Bennett, Cheshire	25.00	
				30.00	17.90

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.						POTASH.			
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
1391	61.6	----	---	0.82	0.82	0.8	5.60	3.45	1.52	10.57	10.0	9.05	8.0	3.28	3.28	4.0
1270	61.8	0.17	---	1.83	2.00	1.7	5.68	3.29	1.62	10.59	9.0	8.97	8.0	3.29	3.29	3.0
271	62.1	0.31	---	2.29	2.60	2.5	6.40	3.39	2.03	11.82	10.0	9.79	9.0	2.20	2.20	2.0
114	62.3	----	---	1.88	1.88	1.7	6.96	2.74	1.21	10.91	10.0	9.70	9.0	2.14	2.14	2.0
34	63.6	----	---	2.53	2.53	2.5	3.97	3.98	2.06	10.01	7.0	7.95	6.0	2.38	2.38	2.0
10	63.9	----	---	1.41	1.41	0.8	7.76	2.78	1.23	11.77	9.0	10.54	7.0	1.84	1.84	2.0
1	64.9	0.38	---	1.60	1.98	2.5	4.72	2.16	0.26	7.14	8.0	6.88	5.0	10.05	10.05	10.0
	65.3	0.62	---	1.29	1.91	1.7	6.02	2.15	1.13	9.30	9.0	8.17	8.0	2.90	2.90	2.0
	66.7	0.44	---	1.93	2.37	2.5	5.44	3.98	2.16	11.58	11.0	9.42	9.0	2.26	2.26	2.0
	67.3	----	---	1.17	1.17	0.8	7.44	1.88	3.11	12.43	10.0	9.32	8.0	1.38	1.38	1.0
	67.6	----	---	2.00	2.00	1.7	6.01	3.08	1.78	10.87	10.0	9.09	9.0	2.26	2.26	2.0

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	<i>Sampled by Station Agent:</i>				
14371	Chittenden's Ammoniated Bone Superphosphate	National Fertilizer Co., Bridgeport....	H. A. Bugbee, Williamantic	\$25.00	\$18.25
14267	Eldredge's Special Fish and Potash Fertilizer	(Made for) T. H. Eldredge, Norwich.	G. A. & H. Williams, Silver Lane..... David Fox, Westbrook	31.00 26.00	16.00
14515	Crocker's New Rival	American Agricultural Chem. Co., N. Y....	T. H. Eldredge, Norwich	29.00	
14541	Bowker's Hill and Drill Phosphate	Bowker Fertilizer Co., N. Y.	F. M. Loomis, No. Granby	30.00	17.37
14190	Swift's Lowell Bone Fertilizer	Swift's Lowell Fertilizer Co., Boston ..	W. T. McKenzie, Yalesville	35.00	20.25
14376	T. H. Eldredge's Special Superphosphate	(Made for) T. H. Eldredge, Norwich.	Standard Feed Co., Bridgeport	31.00	17.67
14475	Darling's General Fertilizer	American Agricultural Chem. Co., N. Y....	F. S. Bidwell & Co., Windsor Locks	31.00	
14516	E. Frank Coe's XXV Ammoniated Bone Phosphate.....	E. Frank Coe Co., N. Y.	David A. Fox, Westbrook	26.00	14.95
			T. H. Eldredge, Norwich	27.00	
14201	Gloucester Fish and Potash	Bowker Fertilizer Co., N. Y.	F. C. Wilcox, Clinton	38.00	20.10
14375	Bowker's Sure Crop Phosphate	Bowker Fertilizer Co., N. Y.	F. M. Cole & Co., Putnam	27.00	14.24
14232	Swift's Lowell Empress Brand	Swift's Lowell Fertilizer Co., Boston ..	Wm. Warner, Westville	28.00 27.50	
14297	Read's Standard Superphosphate	American Agricultural Chem. Co., N. Y....	Lightbourn & Pond Co., New Haven..... W. T. McKenzie, Yalesville	25.00 25.00	12.55
14539	Quinnipiac Climax Phosphate	American Agricultural Chem. Co., N. Y....	Southington Lumber Co., Southington	29.00	14.60
14298	Packer's Union Universal Fertilizer.....	American Agricultural Chem. Co., N. Y....	A. R. Manning, Yantic	28.00 28.50	
			A. L. Burdick, Westbrook	25.00	13.30
			Waldo Tillinghast, Plainfield	27.00 26.00	
			Carlos Bradley, Ellington	27.50	14.05
			J. A. Nichols, Danielson	30.00 28.75	
			The F. S. Platt Co., New Haven	30.00	14.75
			G. A. Forsyth, Watford	28.00	13.74
			F. L. Mackey, Ellington.....	28.00	

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.							POTASH.		
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
371	69.4	0.18	---	1.92	2.10	1.7	6.51	2.51	1.47	10.49	10.0	9.02	8.0	2.50	2.50	2.0
267	71.0	----	0.46	1.52	1.98	1.7	2.59	3.05	2.04	7.68	6.0	5.64	5.0	4.87	4.87	4.0
15	72.7	----	---	1.81	1.81	1.0	7.24	1.65	2.28	11.17	9.0	8.89	8.0	2.26	2.26	2.0
11	72.8	0.60	---	1.85	2.45	2.5	7.16	3.20	1.22	11.58	10.0	10.36	9.0	2.21	2.21	2.0
10	75.4	0.08	---	1.80	1.88	1.6	6.16	2.32	1.06	9.54	9.0	8.48	8.0	3.43	3.43	3.0
5	80.2	----	0.23	1.10	1.33	1.0	2.99	6.00	1.97	10.96	10.0	8.99	8.0	2.14	2.14	1.5
	89.1	0.30	0.18	2.07	2.55	1.3	4.18	3.12	1.55	8.85	7.0	7.30	6.0	4.60	4.60	3.0
	93.1	----	---	1.18	1.18	0.8	4.80	2.79	4.09	11.68	10.0	7.59	7.0	1.92	1.97	1.5
	94.6	0.30	---	0.74	1.04	0.8	6.27	2.11	1.50	9.88	9.0	8.38	8.0	1.36	1.36	1.0
	95.2	0.19	---	1.02	1.21	0.8	5.44	3.47	1.70	10.61	10.0	8.91	9.0	2.14	2.14	2.0
	95.5	----	---	1.32	1.32	1.2	5.14	1.97	0.78	7.89	8.0	7.11	7.0	2.24	2.24	2.0
	6.5	----	---	0.99	0.99	0.8	4.37	3.57	1.37	9.31	9.0	7.94	8.0	4.27	4.27	4.0
	.4	----	---	1.34	1.34	1.0	6.59	1.93	0.96	9.48	8.0	8.52	6.0	2.28	2.28	1.0
	.8	----	---	0.88	0.88	0.8	4.43	2.78	1.39	8.60	9.0	7.21	8.0	4.36	4.36	4.0

NITROGENOUS SUPERPHOSPHATES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton
	<i>Sampled by Station Agent:</i>				
14510	Essex Al Superphosphate	Russia Cement Co., Gloucester, Mass.	W. O. Goodsell, Bristol F. C. Benjamin, Danbury W. J. Cox, East Hartford	\$27.00 30.00 28.00 28.25	\$13.50
14518	Great Eastern General Fertilizer	American Agricultural Chem. Co., N. Y.	T. E. Greene, Plainfield	29.00	13.42
14529	Bradley's Niagara Phosphate	American Agricultural Chem. Co., N. Y.	Wilson & Burr, Middletown Phineas Platt, Milford	25.00 27.00 26.00	12.25
14538	Bowker's Potash Bone	Bowker Fertilizer Co., N. Y.	A. R. Manning, Yantic	25.00	11.46
14373	General Crop Fish Guano	Ohio Farmers' Fertilizer Co., Columbus, O.	R. B. Witter, Brooklyn R. A. Sherman, Oneco	22.00 21.00 21.50	9.68
14528	Bradley's Eclipse Phosphate	American Agricultural Chem. Co., N. Y.	Phineas Platt, Milford F. M. Cole & Co., Putnam	30.50 32.00 31.25	14.06
	<i>Sampled by Purchasers and others:</i>	<i>Manufacturer or dealer.</i>	<i>Sent by</i>		
14560	Woodruff's Home Mixture	S. D. Woodruff & Sons, Orange	W. L. Dickinson, South Britain	25.00 27.00	27.30
14081	E. B. Clark's Special Mixture	E. B. Clark Co., Milford	Samuel M. Canfield, Milford	29.00	27.20
14306	Bone, Fish and Potash	E. R. Kelsey, Branford	D. W. Patten, Clintonville	24.50	22.60
13997	.....	Olds & Whipple, Hartford	Willard E. Treat, Silver Lane	35.00	20.21
14290	Shay's Special Mixture	C. M. Shay Fertilizer Co., Groton	Thomas G. Whipple, Mystic	20.00	16.60
14291	Atlantic Coast Bone, Fish and Potash	Sanderson Fertilizer & Chemical Co., New Haven	Thomas G. Whipple, Mystic	23.00	18.67
14126	Swift's Animal Brand Fertilizer	Swift's Lowell Fertilizer Co., Boston	J. L. Watrous, R. F. D., Kensington	30.00	22.54
14481	James' Bone Phosphate	Ernest L. James, Warrenville	Manufacturer	30.00	21.70
14561	Packers' Union Universal Fertilizer	American Agricultural Chem. Co., N. Y.	W. L. Dickinson, South Britain	25.50	16.00
14555	Baker's A. A. Ammoniated Superphosphate	American Agricultural Chem. Co., N. Y.	Arthur Brown, Hills-town	32.00	19.73
15126	Peruvian Guano	Sanderson Fertilizer & Chemical Co., New Haven	Geo. S. Champlin, Ashaway, R. I.	40.00	19.73

ANALYSES AND VALUATIONS—*Concluded.*

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.						POTASH.		
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.	
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Murrate.	Guaranteed.
14510	107.9	----	----	1.21	1.21	1.0	1.76	4.82	5.28	11.86	9.0	6.58	7.0	1.84	2.0
14518	108.3	----	----	0.97	0.97	0.8	4.40	3.03	1.33	8.76	9.0	7.43	8.0	4.02	4.0
14529	112.2	0.07	----	1.15	1.22	0.8	3.44	3.39	1.79	8.62	8.0	6.83	7.0	1.43	1.0
14538	118.2	----	----	0.99	0.99	0.8	2.51	3.85	1.44	7.80	7.0	6.36	6.0	2.21	2.0
14373	122.1	trace	----	0.35	0.35	0.8	3.12	5.11	2.13	10.36	9.0	8.23	7.0	0.45	1.0
14528	122.3	----	----	1.18	1.18	1.0	6.16	2.14	1.59	9.89	9.0	8.30	8.0	2.12	2.0
14560	*1.1	1.46	----	2.75	4.21	3.3	4.10	4.14	1.35	9.59	8.0	8.24	----	5.44	8.0
14081	6.3	0.75	0.18	2.55	3.48	3.3	4.85	4.95	2.19	11.99	8.0	9.80	----	6.42	7.0
14306	8.4	----	0.45	2.65	3.10	2.5	3.49	3.20	0.28	6.97	5.0	6.69	4.0	0.36	4.0
13997	19.8	0.30	0.29	4.19	4.78	----	0.50	4.42	0.85	5.77	----	4.92	----	0.53	----
14290	20.5	0.20	----	1.66	1.86	----	2.91	3.59	6.23	12.73	----	6.50	----	2.12	----
14291	23.2	----	0.29	1.96	2.25	1.7	3.42	3.99	0.80	8.21	6.0	7.41	4.0	1.76	4.0
14126	33.1	----	----	2.64	2.64	2.5	6.61	3.33	1.25	11.19	10.0	9.94	9.0	4.30	4.0
14481	37.9	----	----	2.35	2.35	----	2.96	7.80	2.67	13.43	----	10.76	----	3.64	----
14561	58.8	0.07	----	1.08	1.15	0.8	7.52	1.85	1.36	10.73	9.0	9.37	8.0	3.56	4.0
14555	62.2	0.28	----	2.08	2.36	2.5	6.00	3.61	2.56	12.17	11.0	9.61	9.0	2.08	2.0
15126	102.8	0.09	0.87	1.08	2.04	----	0.54	10.22	4.34	15.10	----	10.76	----	2.29	----

* Valuation exceeds cost.

SPECIAL MANURES.

Here are included such mixed fertilizers, chiefly nitrogenous superphosphates, as are claimed by their manufacturers to be specially adapted to the needs of particular crops. Those which are claimed to contain potash in form of carbonate are separately discussed on pages 96 and 97.

1. Samples Drawn by Station Agent.

In the table on pages 78-95 are given analyses of one hundred and fifteen brands represented by samples drawn by the Station agents.

Analyses requiring Special Notice.

The Buffalo Fertilizer Co. states that analysis No. **14328**, pages 80 and 81, does not present the average composition of its Vegetable and Potato Manure. The company states that, although thoroughly mixed at the factory, the mixture has a tendency to separate in the bags on handling, the sulphate of potash particularly working towards the bottom and sides of the bags.

The sampling agent was not able to find other lots of this brand in dealer's hands, after the manufacturer's protest was received, or other tests would have been made on this brand.

The C. M. Shay Fertilizer Co. stated that analysis No. **14303**, pages 86 and 87, does not fairly represent their Grass Fertilizer. It was not possible to get another sample for analysis from the stock of a dealer, after this protest was received.

A second analysis, **14542**, pages 94 and 95, was made on a sample sent by the manufacturer.

14454. A sample described by our sampling agent as Darling's Tobacco Grower, drawn from stock of William Bartman, East Haddam, with a guaranty of nitrogen 4.5 per cent., phosphoric acid 5.0, and potash 10.0, contains nitrogen 8.56 per cent., phosphoric acid 8.55 and potash 4.72. The analysis does not agree in any particular with the guaranty, and it is quite obvious that some error has been made, the nature or source of which it is impossible to determine.

Two samples drawn by our agent, one at the factory and the other from C. D. Torrey, Putnam, and marked Sanderson's Top Dressing for Grass and Grain, were mixed and analyzed, No. 14324.

The mixture contains nitrogen 3.43 per cent., phosphoric acid 9.21 and potash 3.83.

The guaranty of this brand is nitrogen 4.0 per cent., "available phosphoric acid" 7.0, and potash 7.0.

The two samples, as was determined later by analysis, were quite different in their composition. Mr. Torrey also states that at the time our agent called he had on hand but a single bag of the Top Dressing.

It is obvious here also that some error has occurred, the precise nature of which cannot now be determined.

GUARANTIES.

Of the one hundred and fifteen fertilizers in the following tables, forty, or more than one-third of the whole number, fail to meet the maker's minimum guaranty in respect of one or more ingredients. Eight are deficient in nitrogen, four in phosphoric acid, and twenty-two in potash. Four of the number are below the minimum guaranty in respect of two ingredients.

The brands which thus fail to meet fully the minimum claims of the manufacturer by more than one-tenth per cent. are the following:—

14433. Bowker's Fairfield Onion Fertilizer. Potash found, 5.88, guaranteed, 6.0.

14455. American Agricultural Chemical Co.'s H. G. Tobacco Manure. Nitrogen found, 5.57, guaranteed, 5.8. Potash found, 9.82, guaranteed, 10.0.

14276. Hubbard's Soluble Tobacco Manure. Potash found, 9.68, guaranteed, 10.0.

14474. Olds & Whipple's Home Mixture for Corn and Potatoes. Potash found, 5.43, guaranteed, 6.0.

14458. Chittenden's H. G. Special Tobacco Fertilizer. Potash found, 9.78, guaranteed, 10.0.

14462. Essex Special Tobacco Manure. Potash found, 11.65, guaranteed, 12.0.

14328.* Buffalo Vegetable and Potato. Nitrogen found, 2.35, guaranteed, 2.5. Potash found, 6.07, guaranteed, 8.0.

14410. Hubbard's Grass and Grain Fertilizer. Potash found, 11.42, guaranteed, 12.0.

* See notice on page 72.

14493. Olds & Whipple's Home Mixture for Grass. Potash found, 5.65, guaranteed, 6.0.
14300. Buffalo Ideal Wheat and Corn. Nitrogen found, 1.45, guaranteed, 1.6.
14549. Sanderson's Top Dressing for Grass and Grain. Potash found, 6.08, guaranteed, 7.0.
14415. Olds & Whipple's H. G. Potato Manure. Potash found, 9.75, guaranteed, 10.0.
14459. Chittenden's Complete Tobacco Fertilizer. Potash found, 5.21, guaranteed, 5.4.
14483. New England Fertilizer Co.'s H. G. Potato Fertilizer. Potash found, 5.67, guaranteed, 6.0.
14465. American Agricultural Chemical Co.'s Tobacco Starter and Grower. Nitrogen found, 3.04, guaranteed, 3.3.
14471. Chittenden's Potato Special. Nitrogen found, 2.32, guaranteed, 2.5.
14230. Lister's Potato Manure. Nitrogen found, 3.04, guaranteed, 3.3.
14413. Lister's Special 10 per cent. Potato. Potash found, 9.63, guaranteed, 10.0.
14443. New England Perfect Tobacco Grower. Potash found, 5.83, guaranteed, 6.0.
14257. Bowker Fertilizer Co.'s Stockbridge Special Corn Manure. Potash found, 6.51, guaranteed, 7.0.
14303. Shay's Grass Fertilizer. Nitrogen found, 2.70, guaranteed, 3.0.
14288. Armour's American Farmers' Complete Potato. Potash found, 5.50, guaranteed, 6.0.
14490. Read's Vegetable and Vine Fertilizer. "Available" phosphoric acid found, 7.69, guaranteed, 8.0.
14254. Great Eastern Vegetable, Vine and Tobacco. Potash found, 5.78, guaranteed, 6.0.
14473. Ohio Farmers' Potato and Tobacco Special. Phosphoric acid found, 9.47, guaranteed, 10.0. Potash found, 3.34, guaranteed, 4.0.
14488. Packers' Union Potato Manure. "Available" phosphoric acid found, 7.29, guaranteed, 8.0. Potash found, 4.99, guaranteed, 6.0.
14526. American Agricultural Chemical Co.'s Grass and Lawn Top Dressing. Nitrogen found, 3.77, guaranteed, 3.9.
14388. Darling's Potato Manure. Potash found, 4.81, guaranteed, 5.0.
14499. Wheeler's Bermuda Onion Grower. Potash found, 3.57, guaranteed, 4.0.
14535. American Agricultural Chemical Co.'s Grass and Oats Fertilizer. "Available" phosphoric acid found, 10.57, guaranteed, 11.0.

In some of these cases, at least, a deficiency of one ingredient is accompanied by a very considerable excess of another; the discrepancies being largely explained by imperfect mixing of the raw materials at the factory.

COST AND VALUATION.

The method of ascertaining the retail cash cost price of the special manures and of computing the valuation is the same as described on page 53.

The average cost per ton of the one hundred and fifteen special manures included in the tables was \$33.99, the valuation, \$23.92, and the percentage difference, 41.8.

In 1904 the corresponding figures were: Average cost, \$33.93; valuation, \$23.39; percentage difference, 45.0.

The average composition and cost of special manures for the last five years, excluding those guaranteed to contain potash as carbonate, have been as follows:

PERCENTAGE COMPOSITION.

Year.	Nitrogen.	Available phosphoric acid.	Potash.	Cost per ton.
1905	2.93	10.38*	6.13	\$33.99
1904	2.92	8.56*	5.92	33.93
1903	3.03	8.00	6.32	33.30
1902	3.03	8.17	6.08	33.35
1901	2.87	8.88	6.44	32.64
1900	2.86	8.90	6.35	32.73

Without regarding the station's valuations, but considering only the retail price of the different brands and their actual composition, it appears that the following amounts of nitrogen, phosphoric acid and potash have been purchasable for \$30.00 in the different groups of special manures.

	Nitrogen, pounds.	Phosphoric acid, pounds.	Potash, pounds.	Cost per ton.
In the first 13 samples in the table	72	169	139	\$37.20
" next 13 " " "	63	181	143	39.36
" " 14 " " "	56	166	129	35.36
" " 13 " " "	55	163	116	34.31
" " 13 " " "	51	172	105	34.84
" " 12 " " "	41	219	86	30.73
" " 11 " " "	43	197	88	31.09
" " 14 " " "	42	194	69	31.77
" " 12 " " "	31	199	71	30.35

These figures agree in their showing with those relating to nitrogenous superphosphates on page 54: That is, *as a rule*,

* Total phosphoric acid.

the cheap or low-priced special manures are really the most costly, when we consider the actual plant food in them. At present the prices of fertilizers bear no constant relation to their real fertilizing value or to the amount of plant food in them; and in some brands of special manures twice as much nitrogen and potash can be bought for the same amount of money as can be bought in certain other brands.

2. Special manures sampled by manufacturers and purchasers.

In the table on pages 94 and 95 are given eight analyses belonging in this class. The station assumes no direct responsibility for the sampling of these goods.

Special Tobacco Manures, claimed to contain potash, either wholly or in part in form of Carbonate.

In the tables on pages 96 and 97 are given twenty-one analyses of mixtures of this kind which require some special explanation, most of it repeated from former reports.

All of these mixtures are claimed to contain potash, largely in form of carbonate, and "available" phosphoric acid. The trade name "available phosphoric acid" has already been discussed on page 34 of this report. It should be added that in strongly alkaline mixtures like these special tobacco manures, from which the alkali cannot be removed by washing with water and which contain no considerable amount of water-soluble phosphates, the conditions prescribed for the use of the ammonium citrate cannot be maintained, and the term "available" phosphoric acid has no definite significance and is of no use in fixing the value of the fertilizer. It is a perfectly meaningless term as applied to such goods as these.

Regarding the guaranty of carbonate of potash, in many cases a chemical analysis cannot certainly prove or disprove the statement that potash is present in that form. The presence of sulphuric acid and chlorine, even in considerable amount, does not necessarily disprove the statement of the manufacturers that the potash in the mixture was introduced wholly as carbonate, for both sulphuric acid and chlorine may have come from other articles used in the mixture, such as acid phosphate,

acid fish, plaster, or whatever else may have been employed along with carbonate of potash.

But the object of using carbonate of potash in tobacco fertilizers is to exclude both chlorides and sulphates. The reason for excluding them is the fear that the quality of the crop will be damaged by their presence.

Our experiments, as well as the experience of growers of tobacco in Connecticut, have also proved that the carbonate is one of the best forms, if not the very best, in which to supply potash to the tobacco crop.

It is an expensive form of potash, but its use is rational, *if thereby sulphates and chlorides are excluded*. But it is quite irrational, because wasteful, to use the relatively expensive carbonate of potash in a mixed fertilizer and to introduce, at the same time, either sulphates or chlorides in other forms than in potash salts, for instance as acid fish, dissolved phosphate, or plaster, for there is no doubt that sulphates or chlorides may be equally harmful to the quality of the tobacco leaf, whether introduced into the fertilizer as potash salts or in other forms.

In making valuations for these fertilizers, potash sufficient to combine with the chlorine present is calculated as chloride; potash sufficient to combine with all the sulphuric acid present is calculated as sulphate, and any excess of potash remaining is then calculated as carbonate. But we repeat that this is merely a calculation for making a valuation and that it does not necessarily conflict with the manufacturers' statements that a part or all of the potash was put into the mixture as high-grade carbonate.

Analysis Requiring Special Notice.

Analysis **14437** of Bowker's Tobacco Ash Elements was made early in the season on a mixture of samples drawn at four different places. Subsequent examination showed that one of these samples was not Tobacco Ash Elements at all. A new mixture was therefore made of the three remaining samples and the analysis of this sample, **16026**, appears in the table.

SPECIAL MANURES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	<i>I. Sampled by Station Agent:</i>				
14329	Boardman's Complete Fertilizer for Potatoes and General Crops	F. E. Boardman, Westfield	Manufacturer	\$32.00	\$28.96
14186	Special Mixture for Seed and Potatoes	The E. B. Clark Co., Milford	Manufacturer	29.00	25.65
14426	E. F. Coe's Tobacco and Onion Fertilizer	The E. Frank Coe Co., New York	C. W. Stowe & Son, Milford * C. W. Beardsley, Milford	32.00 32.00	28.14
14417	H. G. Grass and Grain Fertilizer	The Rogers Mfg. Co., Rockfall	Manufacturer	40.00	35.08
14301	Shay's Potato Manure	The C. M. Shay Fertilizer Co., Groton	Manufacturer	30.00	26.11
14322	Wilcox' Potato, Onion and Vegetable Manure	Wilcox Fertilizer Works, Mystic	I. W. Dennison & Co., Mystic M. E. Thompson, Ellington	34.00 32.00 33.00	28.35
14460	H. G. Soluble Tobacco Manure	The Rogers Mfg. Co., Rockfall	W. G. Wrisley, Windsor Arthur Sikes, Suffield †	44.00 43.00	36.79
14433	Bowker's Fairfield Onion Fertilizer	Bowker Fertilizer Co., N. Y.	Bowker's Branch, Southport	32.00	27.12
14326	Hubbard's Oats and Top Dressing	The Rogers and Hubbard Co., Middletown	H. W. Andrews, Wallingford John Bransfield, Portland	52.00 51.00 51.50 34.00	43.31
14393	Wilcox' Grass Fertilizer	Wilcox Fertilizer Works, Mystic	Manufacturer Spencer Bros., Suffield	34.00 34.00	28.14
14455	H. G. Tobacco Manure	American Agricultural Chemical Co., N. Y.	E. N. Austin, Suffield	44.00	35.92
14282	Essex Complete Manure for Potatoes, Roots and Vegetables	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford Broad Brook Lumber Co., Broad Brook	39.00 39.00	31.80
14325	H. G. Fertilizer for Oats and Top Dressing	The Rogers Mfg. Co., Rockfall	S. I. Munson, East Wallingford R. E. Davis, Guilford	44.00 42.00 44.00	35.80
14276	Hubbard's Soluble Tobacco Manure	The Rogers and Hubbard Co., Middletown	A. E. Kilbourne, East Hartford H. W. Andrews, Wallingford	47.00 45.00 46.00	37.29
14461	H. G. Soluble Tobacco and Potato Manure	The Rogers Mfg. Co., Rockfall	Arthur Sikes, Suffield E. S. Hale, Portland	39.00 39.00	31.58

* Purchaser.

† Stock of L. A. Kent, Suffield.

ANALYSES AND VALUATIONS.

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.						POTASH.			
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
14329	10.4	0.14	---	3.34	3.48	2.8	5.79	2.47	0.95	9.21	----	8.26	6.0	10.08	10.08	10.0
14186	13.1	0.88	---	2.47	3.35	3.3	5.60	2.52	0.92	9.04	8.0	8.12	----	7.16	7.16	7.0
14426	13.7	----	1.25	2.29	3.54	3.0	5.09	1.88	1.54	8.51	7.0	6.97	6.0	0.84	8.72	8.0
14417	14.0	----	---	3.11	3.11	3.0	none	11.07	7.10	18.17	16.0	11.07	----	13.96	13.96	12.5
14301	14.9	0.73	---	2.27	3.00	3.0	2.53	6.97	3.42	12.92	9.0	9.50	8.0	5.00	6.75	5.0
14322	16.4	1.22	---	2.65	3.87	3.3	6.36	2.51	1.11	9.98	8.0	8.87	7.0	4.87	6.95	6.0
14460	16.9	1.80	---	3.12	4.92	5.0	1.12	7.82	1.87	10.81	8.0	8.94	6.0	0.69	11.21	11.0
14433	18.0	0.90	---	2.98	3.88	3.3	5.68	3.16	0.97	9.81	9.0	8.84	8.0	5.88	5.88	6.0
14326	18.9	7.25	---	1.19	8.44	8.5	0.00	6.43	3.04	9.47	8.0	6.43	3.9	9.29	9.29	8.0
14393	20.8	1.72	---	2.66	4.38	4.1	3.73	5.18	1.67	10.58	7.0	8.91	----	5.03	5.03	5.0
14455	22.5	----	2.93	2.64	5.57	5.8	5.65	1.09	0.65	7.39	6.0	6.74	5.0	1.00	9.82	10.0
14282	22.6	0.76	---	3.14	3.90	3.7	4.64	3.10	4.20	11.94	9.0	7.74	----	0.72	9.37	8.5
14325	22.9	4.87	---	1.63	6.50	6.3	2.05	5.21	1.75	9.01	9.0	7.26	7.0	7.64	7.64	7.5
14276	23.4	2.94	0.31	2.10	5.35	5.0	0.59	8.56	3.83	12.98	10.0	9.15	7.0	1.09	9.68	10.0
14461	23.5	1.47	---	2.01	3.48	3.5	0.77	9.37	3.23	13.37	9.0	10.14	7.0	0.93	9.80	8.8

SPECIAL MANURES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	<i>1. Sampled by Station Agent:</i>				
14250	Hubbard's Soluble Potato Manure.....	The Rogers & Hubbard Co., Middletown.....	H. W. Andrews, Wallingford..... A. E. Kilbourne, East Hartford.....	\$40.00 42.00 41.00	\$33.07
14185	Swift-Sure Superphosphate for Potatoes.....	M. L. Shoemaker & Co., Phila., Pa.....	F. H. Rolf, Guilford..... A. N. Clark, Milford.....	35.00 34.50 34.75	27.94
14474	O. & W's. Home Mixture for Corn and Potatoes.....	Olds & Whipple, Hartford.....	Manufacturer.....	32.00	25.72
14458	Chittenden's H. G. Special Tobacco Fertilizer.....	National Fertilizer Co., Bridgeport.....	J. N. Lasbury, Broad Brook..... W. E. Burbank, Suffield.....	44.00 46.00 45.00	36.16
14462	Essex Special Tobacco Manure.....	Russia Cement Co., Gloucester, Mass.....	W. J. Cox, East Hartford..... Spencer Bros., Suffield.....	45.00 47.00 46.00	36.57
14463	Mapes' Seeding Down Manure.....	Mapes F. & P. G. Co., N. Y.....	Mapes' Branch, Hartford.....	40.00	31.74
14328*	Buffalo Vegetable and Potato.....	The Buffalo Fertilizer Co., Buffalo, N. Y.....	J. H. Atkins, Middletown..... W. H. H. Chappell, R. F. D., Oakdale.....	30.00 33.00 31.50	24.86
14434	Stockbridge Grass Top Dressing.....	Bowker Fertilizer Co., N. Y.....	Bowker's Branch, Hartford.....	38.00	29.94
14430	Essex Grass and Top Dressing Fertilizer.....	Russia Cement Co., Gloucester, Mass.....	W. J. Cox, East Hartford.....	43.00	33.87
14410	Hubbard's Grass and Grain Fertilizer.....	The Rogers & Hubbard Co., Middletown.....	City Coal & Wood Co., New Britain..... John Bransfield, Portland.....	41.00 40.00 40.50	31.81
14323	H. G. Complete Corn and Onion Manure.....	The Rogers Mfg. Co., Rockfall.....	Manufacturer..... R. E. Davis, Guilford.....	35.00 34.00	27.13
14564	Swift-Sure Guano for Truck, Corn and Onions.....	M. L. Shoemaker & Co., Phila., Pa.....	A. N. Clark, Milford..... F. H. Rolf, Guilford.....	28.00 28.00	21.63
14457	Stockbridge Special Tobacco Manure.....	Bowker Fertilizer Co., N. Y.....	Bowker's Branch, Hartford.....	47.00	36.29
14424	Mapes' Economical Potato Manure.....	Mapes F. & P. G. Co., N. Y.....	Mapes' Branch, Hartford..... W. C. Bulkley, Forestville.....	35.00 36.00	26.73
14464	Sanderson's Formula B for Tobacco.....	Sanderson Fertilizer & Chemical Co., New Haven.....	J. H. Hackett, Wapping..... Manufacturer.....	35.00 35.00	26.65

* See notice on page 72.

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.						POTASH.			
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		Guaranteed.
					Found.	Guaran- teed.				Found.	Guaran- teed.	Found.	Total.	As Muriate.	Total.	
14250	24.0	2.84	0.30	2.06	5.20	5.0	0.56	9.00	3.40	12.96	10.0	9.56	7.0	1.06	5.84	5.0
14185	24.4	0.68	---	2.20	2.88	2.9	7.53	3.20	0.63	11.36	---	10.73	---	9.29	9.29	7.0
14474	24.4	----	0.60	3.13	3.73	3.3	3.92	3.66	0.74	8.32	----	7.58	7.0	0.97	5.43	6.0
14458	24.4	----	2.89	2.75	5.64	5.7	4.75	1.96	0.90	7.61	7.0	6.71	5.0	0.88	9.78	10.0
14462	25.8	1.55	---	3.31	4.86	4.5	4.56	2.80	3.00	10.36	7.5	7.36	5.5	0.96	11.65	12.0
14463	26.0	1.85	0.26	0.94	3.05	2.5	0.19	9.49	9.00	18.68	18.0	9.68	----	11.41	11.41	10.0
14328	26.7	----	---	2.35	2.35	2.5	7.07	3.53	2.42	13.02	9.0	10.60	8.0	0.43	6.07	8.0
14434	26.9	1.72	---	3.40	5.12	4.9	2.48	3.89	1.75	8.12	5.0	6.37	4.0	6.44	6.44	6.0
14430	27.0	3.09	---	2.00	5.09	5.0	4.91	3.87	2.76	11.54	10.0	8.78	8.0	8.63	8.63	8.0
14410	27.3	----	0.17	2.83	3.00	2.2	0.25	9.97	6.98	17.24	16.0	10.26	----	11.42	11.42	12.0
14323	29.0	2.03	---	1.92	3.95	3.6	3.12	2.91	3.50	9.53	8.0	6.03	6.0	7.75	7.75	7.0
14564	29.4	0.70	---	1.37	2.07	1.7	7.01	3.27	1.11	11.39	----	10.28	----	5.66	5.66	5.0
14457	29.5	1.50	0.35	4.03	5.88	5.8	2.16	3.09	2.04	7.29	5.0	5.25	4.0	1.18	10.00	10.0
14424	30.9	2.74	0.26	0.67	3.67	3.3	2.48	3.49	0.96	6.93	6.0	5.97	4.0	1.40	8.83	8.0
14464	31.3	1.12	---	2.17	3.29	3.3	2.24	4.39	3.36	9.99	10.0	6.63	6.0	1.57	8.18	6.0

SPECIAL MANURES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	<i>1. Sampled by Station Agent:</i>				
14456	Wheeler's Havana Tobacco Grower	American Agricultural Chemical Co., N. Y.	F. M. Loomis, North Granby	\$38.00	\$28.67
14419	Baker's Complete Potato Manure	American Agricultural Chemical Co., N. Y.	Edward White, Rockville	36.00	26.86
14511	Shay's Corn Manure	C. M. Shay Fertilizer Co., Groton	Manufacturer	26.00	19.40
14195	Mapes' Potato Manure	Mapes F. & P. G. Co., N. Y.	Spencer Bros., Suffield Mapes' Branch, Hartford	39.00 38.00	28.29
14493	O. & W's. Home Mixture for Grass	Olds & Whipple, Hartford	Manufacturer	34.00	25.23
14300	Buffalo Ideal Wheat and Corn	Buffalo Fertilizer Co., Buffalo, N. Y.	J. H. Atkins, Middletown, R. D. 2. R. H. Hall, East Hampton	26.00 30.00 28.00	20.68
14283	Essex Complete Manure for Corn, Grain and Grass	Russia Cement Co., Gloucester, Mass.	W. J. Cox, East Hartford Broad Brook Lumber Co., Broad Brook	39.00 40.00 39.50	29.09
14549	Sanderson Top Dressing for Grass and Grain	Sanderson Fertilizer & Chemical Co., New Haven	Manufacturer	38.00	27.68
14253	Bradley's Complete Manure for Potatoes and Vegetables	American Agricultural Chemical Co., N. Y.	C. Buckingham, Southport Avery Bros., Norwich Town	32.00 38.00 37.00	26.91
14218	Bowker's Early Potato Manure	Bowker Fertilizer Co., N. Y.	Bowker's Branch, Southport Bowker's Branch, Hartford	31.00 35.00 36.00	26.15
14220	Stockbridge Potato and Vegetable Manure	Bowker Fertilizer Co., N. Y.	Bowker's Branch, Hartford Lightbourn & Pond Co., New Haven	38.00 40.00	27.60
14415	O. & W's. H. G. Potato Manure	Olds & Whipple, Hartford	Manufacturer	37.00	26.84
14200	Armour's H. G. Potato	Armour Fertilizer Works, Baltimore, Md.	Brower & Malone, Norwalk H. M. Clayton, New Britain	34.00 33.00 33.50	24.26
14425	Hubbard's Soluble Corn and General Crops	The Rogers & Hubbard Co., Middletown	City Coal & Wood Co., New Britain H. W. Andrews, Wallingford	35.00 35.00	25.16

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.							POTASH.		
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
14456	32.5	----	0.70	2.12	2.82	2.5	6.40	1.07	0.46	7.93	7.0	7.47	6.0	1.14	11.75	10.0
14419	34.0	0.66	0.09	2.50	3.25	3.3	3.41	3.47	1.69	8.57	7.0	6.88	6.0	10.02	10.02	10.0
14511	34.0	0.06	---	1.99	2.05	1.6	2.96	5.43	5.04	13.43	9.0	8.39	8.0	3.32	3.32	2.5
14195	34.3	2.88	0.35	0.59	3.82	3.7	3.92	4.94	1.09	9.95	8.0	8.86	8.0	1.54	7.40	6.0
14493	34.8	0.90	---	2.82	3.72	3.3	2.72	4.17	1.27	8.16	----	6.89	6.0	1.40	5.65	6.0
14300	35.4	----	---	1.45	1.45	1.6	5.92	4.11	3.02	13.05	----	10.03	9.0	0.44	5.55	5.0
14283	35.8	0.85	---	2.59	3.44	3.3	4.77	4.51	1.31	10.59	9.5	9.28	7.0	9.65	9.65	9.5
14549	37.3	1.98	---	1.94	3.92	4.0	5.98	3.31	1.42	10.71	----	9.29	7.0	6.08	6.08	7.0
14253	37.5	1.35	0.47	1.48	3.30	3.3	5.95	3.35	1.61	10.91	9.0	9.30	8.0	4.85	7.24	7.0
14218	37.7	0.67	0.28	2.46	3.41	3.3	5.92	1.99	0.92	8.83	8.0	7.91	7.0	7.65	7.65	7.0
14220	37.7	0.76	---	2.62	3.38	3.3	4.32	2.96	0.91	8.19	7.0	7.28	6.0	10.25	10.25	10.0
14415	37.9	0.10	0.58	2.83	3.51	3.3	1.68	4.34	1.83	7.85	----	6.02	6.0	9.75	9.75	10.0
14200	38.1	----	---	1.81	1.81	1.7	7.12	2.66	0.58	10.36	10.0	9.78	8.0	10.34	10.34	10.0
14425	39.1	1.49	---	1.27	2.76	2.5	2.62	5.47	1.82	9.91	8.0	8.09	6.	9.32	9.32	8.0

SPECIAL MANURES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	<i>I. Sampled by Station Agent:</i>				
14459	Chittenden's Complete Tobacco Fertilizer	National Fertilizer Co., Bridgeport	Thomas Cavanaugh, Gildersleeve James T. Kane,* Suffield	\$38.00 37.00 37.50	\$26.90
14483	New England High Grade Potato Fertilizer	New England Fertilizer Co., Boston	J. A. Lewis & Co., Willimantic	33.00	23.65
14215	Wilcox' Potato Fertilizer	Wilcox Fertilizer Works, Mystic	I. W. Dennison & Co., Mystic D. C. Spencer, Saybrook	27.00 29.00 28.00	19.96
14486	Swift's Special Grass Mixture	Swift's Lowell Fertilizer Co., Boston	D. W. Barnes, Windsor Edward White, Rockville	38.00	27.01
14199	Quinnipiac Potato Manure	American Agricultural Chemical Co., N. Y.	C. Buckingham, Southport Gault Bros., Westport	28.00 30.00 29.00	20.55
14465	Tobacco Starter and Grower	American Agricultural Chemical Co., N. Y.	C. M. Beach, New Milford E. N. Austin, Suffield	36.00 32.00 34.00	24.02
14466	Tobacco Starter	The Rogers Mfg. Co., Rockfall	H. A. Clarke, Portland* Manufacturer	35.00 35.00	24.41
14487	Swift's Lowell Lawn Dressing	Swift's Lowell Fertilizer Co., Boston	Strong & Tanner, East Winsted	38.00	26.45
14255	Berkshire Potato and Vegetable Phosphate	Berkshire Fertilizer Co., Bridgeport	Avery Bros., Norwich Town Manufacturer Johnson Bros., Jewett City	31.00 30.00 30.00	20.87
14471	Chittenden's Potato Special	National Fertilizer Co., Bridgeport	H. A. Bugbee, Willimantic	34.00	23.55
14230	Lister's Potato Manure	Lister's Agric. Chem. Wks., Newark, N. J.	J. C. Wilcoxson, Stratford C. D. Babcock, Jewett City	36.00 38.00 37.00 31.00	25.00
14299	Complete Potato and Vegetable Fertilizer	The Rogers Mfg. Co., Rockfall	R. E. Davis, Guilford S. I. Munson, E. Wallingford	33.00 32.00	22.19
14445	Swift's Lowell Perfect Tobacco Grower	Swift's Lowell Fertilizer Co., Boston	J. & H. Woodford, Avon J. B. Pease, Melrose F. S. Bidwell & Co., Windsor Locks	40.00 38.00 41.00 39.50	27.36

* Purchaser.

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.							POTASH.		
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Murate.	Total.	Guaranteed.
4459	39.4	----	1.42	2.26	3.68	3.3	7.52	1.70	0.82	10.04	10.0	9.22	8.0	0.65	5.21	15.4
4483	39.4	----	---	2.65	2.65	2.5	6.35	2.75	1.43	10.53	9.0	9.10	8.0	1.94	5.67	6.0
4215	40.3	0.60	0.30	1.41	2.31	2.1	4.38	3.16	1.48	9.02	7.0	7.54	----	5.40	5.40	4.5
4186	40.7	0.95	0.15	2.86	3.96	4.1	5.48	2.39	1.00	8.87	8.0	7.87	7.0	6.39	6.39	6.0
4099	41.1	0.72	---	1.90	2.62	2.5	5.12	2.09	1.34	8.55	7.0	7.21	6.0	5.00	5.00	5.0
4055	41.5	0.10	1.39	1.55	3.04	3.3	7.20	1.99	1.30	10.49	9.0	9.19	8.0	0.53	4.56	4.0
406	43.2	1.61	0.17	2.42	4.20	3.8	1.07	2.91	5.44	9.42	5.0	3.98	4.0	0.55	4.03	3.0
407	43.5	1.06	3.02	0.17	4.25	4.1	5.04	2.37	0.65	8.06	8.0	7.41	7.0	1.89	5.26	5.0
405	43.7	----	---	2.36	2.36	1.7	3.04	6.24	0.65	9.93	8.0	9.28	6.0	4.88	4.88	4.0
44.1	0.72	---	1.60	2.32	2.5	4.22	2.44	1.40	8.06	8.0	6.66	5.0	10.47	10.47	10.0	
44.2	0.35	1.24	1.45	3.04	3.3	6.77	2.59	0.87	10.23	9.0	9.36	8.0	7.35	7.35	7.0	
44.2	trace	---	2.38	2.38	2.3	4.96	3.44	4.52	12.92	10.0	8.40	8.0	5.13	5.13	5.0	
44.4	0.90	0.14	3.05	4.09	4.1	4.80	3.25	0.97	9.02	----	8.05	7.0	5.39	6.02	6.0	

† "Ten per cent. sulphate."

SPECIAL MANURES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	<i>1. Sampled by Station Agent:</i>				
14296	American Farmers' Corn King	Armour Fertilizer Works, Baltimore..	H. T. Child, Woodstock	\$31.00	\$21.11
			Alfred Ennis, Danielson	30.00	
14278	Hubbard's Potato Phosphate	The Rogers & Hubbard Co., Middletown	H. W. Andrews, Wallingford	30.50	
			E. T. Clark, Milford	31.00	21.75
14413	Lister's Special 10% Potato	Lister's Agri. Chem. Wks., Newark, N. J.	C. D. Babcock, Jewett City	32.00	23.48
14368	Packers' Union Animal Corn Fertilizer	American Agricultural Chemical Co., N. Y.	G. A. Forsyth, Waterford	32.00	21.67
			H. F. Porter, Hebron	31.00	
14443	New England Perfect Tobacco Grower ...	New England Fertilizer Co., Boston.	Latham & Chittenden, Granby	31.50	
			Warner & Hardin, Glastonbury	40.00	27.14
14484	O. & W's. Potato Fertilizer	Olds & Whipple, Hartford	Manufacturer	39.00	
14189	Swift's Lowell Potato Phosphate	Swift's Lowell Fertilizer Co., Boston.	Standard Feed Co., Bridgeport	32.00	21.97
			Spencer Bro., Suffield	34.00	23.67
14527	Bradley's Complete Manure for Top Dressing Grass and Grain	American Agricultural Chemical Co., N. Y.	G. L. Dennis, Stafford Springs	35.00	
			S. J. Stevens, Glastonbury	37.00	25.62
14257	Stockbridge Special Corn Manure	Bowker Fertilizer Co., N. Y.	A. R. Manning, Yantic	38.00	
			W. T. McKenzie, Yalesville	37.50	
14467	Essex Tobacco Starter ..	Russia Cement Co., Gloucester, Mass..	J. & H. Woodford, Avon	40.00	26.75
			H. C. Aborn & Son, Ellington	39.00	
14236	Essex Market Garden and Potato Manure	Russia Cement Co., Gloucester, Mass..	Spencer Bros., Suffield	39.50	
			W. J. Cox, East Hartford	35.00	
14500	Wheeler's Potato Manure	American Agricultural Chemical Co., N. Y.	A. R. Manning, Yantic	34.00	
14303*	Shay's Grass Fertilizer	C. M. Shay Fertilizer Co., Groton	W. H. Baldwin, Cheshire	30.00	20.05
14389	Crocker's Ammoniated Corn Phosphate	American Agricultural Chemical Co., N. Y.	Manufacturer	35.00	23.08
			F. M. Loomis, North Granby	28.00	18.46
			W. L. Wellwood, So. Coventry	32.00	

* See notice on page 72.

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.						POTASH.			
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Total.			
14296	44.5	----	---	2.39	2.39	2.5	5.76	3.67	1.67	11.10	9.0	9.43	8.0	4.09	4.09	4.0
14278	44.6	0.91	---	1.15	2.06	2.0	6.00	5.00	0.71	11.71	10.0	11.00	9.0	5.59	5.59	5.0
14413	44.8	0.46	---	1.47	1.93	1.7	6.51	2.48	1.12	10.11	----	8.99	8.0	9.63	9.63	10.0
14368	45.4	0.70	---	2.08	2.78	2.5	6.14	3.57	2.64	12.35	11.0	9.71	9.0	2.52	2.52	2.0
14443	45.6	0.85	---	3.27	4.12	4.1	4.48	3.18	1.18	8.84	8.0	7.66	7.0	4.79	5.83	6.0
14484	45.7	----	0.65	2.17	2.82	2.5	2.88	2.75	0.65	6.28	----	5.63	5.0	0.90	6.74	6.0
14189	45.8	----	---	2.59	2.59	2.5	5.04	3.63	1.37	10.04	9.0	8.67	8.0	1.01	6.25	6.0
14527	46.4	2.94	0.39	1.49	4.82	4.9	2.51	3.56	2.12	8.19	6.0	6.07	5.0	2.11	3.10	2.5
14257	47.7	1.10	---	2.10	3.20	3.3	7.41	3.36	0.87	11.64	11.0	10.77	10.0	6.51	6.51	7.0
14467	48.6	1.36	---	1.21	2.57	2.5	5.76	4.01	4.75	14.52	12.0	9.77	9.0	0.47	3.56	2.5
14236	49.1	0.53	---	1.72	2.25	2.0	6.00	4.21	2.01	12.22	10.0	10.21	8.0	5.97	5.97	5.0
14500	49.6	----	---	2.37	2.37	2.1	7.15	0.96	2.01	10.12	9.0	8.11	8.0	3.85	3.85	3.0
14303	51.6	1.31	---	1.39	2.70	3.0	2.40	5.81	4.67	12.88	9.0	8.21	8.0	5.66	5.66	5.0
14389	51.7	0.22	---	1.82	2.04	2.1	6.91	2.38	2.54	11.83	9.0	9.29	8.0	2.17	2.17	1.5

SPECIAL MANURES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	<i>I. Sampled by Station Agent:</i>				
14288	American Farmers' Complete Potato	Armour Fertilizer Works, Baltimore, Md.	Alfred Ennis, Danielson H. T. Child, Woodstock	\$29.00 30.00 29.50	\$19.31
14468	Bowker's Tobacco Starter	Bowker Fertilizer Co., N. Y.	E. F. Miller, Ellington Bowker's Branch, Southport	32.00 33.00	21.60
14491	Sanderson's Potato Manure	Sanderson Fertilizer and Chemical Co., New Haven	Manufacturer R. H. Hall, East Hampton	30.00 30.00	19.62
14496	E. F. Coe's New Englander Corn Fertilizer	E. Frank Coe Co., N. Y.	Wm. E. Warner, Westville F. M. Cole & Co., Putnam	28.00 30.00	18.31
14498	E. F. Coe's Celebrated Special Potato Fertilizer	E. Frank Coe Co., N. Y.	Young Bros. Co., Danielson A. L. Burdick, Westbrook Warner & Hardin, Glastonbury	26.00 30.00 31.00 30.50	19.92
14277	Hubbard's Corn Phosphate	The Rogers & Hubbard Co., Middletown	H. W. Andrews, Wallingford E. T. Clark, Milford A. E. Kilbourne, E. Hartford	26.00 30.00 27.00 27.75	18.03
14231	Lister's Special Corn and Potato Fertilizer	Lister's Agric. Chem. Wks., Newark, N. J.	C. D. Babcock, Jewett City J. C. Wilcoxson, Stratford	30.00 28.00 29.00	18.76
14490	Read's Vegetable and Vine Fertilizer	American Agricultural Chemical Co., N. Y.	L. M. Childs, No. Grosvenordale	32.00	20.69
14237	Chittenden's Potato Phosphate	National Fertilizer Co., Bridgeport	A. H. Cashen, Meriden J. W. Potter, Norwich	34.00 32.00 33.00	21.31
14272	Bradley's Potato Fertilizer	American Agricultural Chemical Co., N. Y.	D. L. Clark, Milford W. H. H. Chappell, R. F. D. Oakdale	29.00 32.00 30.50	19.64
14531	Armour's Grain Grower	Armour Fertilizer Wks., Baltimore, Md.	Young Bros. Co., Danielson H. M. Clayton, New Britain	25.00 27.00 26.00	16.70

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.						POTASH.			
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Murate.	Total.	
14288	52.8	----	----	1.72	1.72	1.6	4.45	4.05	2.08	10.58	8.0	8.50	7.0	4.23	5.50	6.0
14468	52.8	----	----	2.60	2.60	2.5	7.28	1.93	1.28	10.49	10.0	9.21	8.0	0.52	3.46	3.0
14491	52.9	0.40	----	1.63	2.03	1.7	3.31	3.45	2.83	9.59	6.0	6.76	5.0	6.31	6.31	6.0
14496	52.9	----	----	1.79	1.79	0.8	5.92	1.84	2.41	10.17	9.0	7.76	7.5	0.80	4.05	3.0
14498	53.1	----	----	2.05	2.05	1.7	7.36	0.83	1.56	9.75	9.5	8.19	8.0	0.65	4.53	4.0
14277	53.9	0.14	----	1.13	1.27	1.0	5.65	5.09	0.65	11.39	10.0	10.74	8.0	4.65	4.65	3.5
14231	54.6	----	----	1.85	1.85	1.7	6.53	3.23	1.50	11.26	9.0	9.76	8.0	3.34	3.34	3.0
14490	54.7	0.37	----	1.68	2.05	2.1	4.06	3.63	2.67	10.36	10.0	7.69	8.0	6.58	6.58	6.0
14237	54.9	0.21	----	1.95	2.16	2.1	5.82	2.87	1.74	10.43	10.0	8.69	8.0	6.05	6.05	6.0
14272	55.3	----	----	2.24	2.24	2.1	5.44	3.41	2.43	11.28	9.0	8.85	8.0	3.23	3.23	3.0
14531	55.7	----	----	1.69	1.69	1.6	5.87	3.36	1.32	10.55	10.0	9.23	8.0	2.29	2.29	2.0

SPECIAL MANURES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	1. <i>Sampled by Station Agent:</i>				
14254	Great Eastern Vegetable, Vine & Tobacco	American Agricultural Chemical Co., N. Y.	T. E. Greene, Plainfield.....	\$33.00	\$21.06
14222	Williams & Clark's Potato Phosphate...	American Agricultural Chemical Co., N. Y.	S. A. Post, Westbrook Phineas Platt, Milford J. G. Schwink, Meriden	33.00 34 50 32.00	21.11
14251	Bradley's Potato Manure	American Agricultural Chemical Co., N. Y.	Avery Bros., Norwich Town Spencer Bros., Suffield	33.25 33.00 34.00	21.23
14333	Mapes' Corn Manure	Mapes F. & P. G. Co., N. Y.	Southington Lumber Co., Southington W. C. Bulkley, Forestville	33.50 36.00 36.00	22.79
14525	Williams & Clark's Americus Corn Phosphate	American Agricultural Chemical Co., N. Y.	Carlos Bradley, Ellington..... J. G. Schwink, Meriden	29.50 30.00	18.50
14473	Potato and Tobacco Special	Ohio Farmers' Fertilizer Co., Columbus, Ohio.	R. A. Sherman, Oneco L. N. Dimmock, New London	29.75 26.00 28.00	16.99
14377	Sanderson's Corn Superphosphate.....	Sanderson Fertilizer & Chemical Co., New Haven	Manufacturer..... C. D. Torrey, Putnam H. A. Bugbee, Willimantic	28.00 28.00 30.00 28.00	17.61
14508	Quinnipiac Corn Manure	American Agricultural Chemical Co., N. Y.	Gault Bros., Westport Young Bros., Co., Danielson	28.00 29.00 28.50	17.82
14497	E. F. Coe's New Eng-lander Potato Fertilizer.....	E. Frank Coe Co., N. Y.	Wm. E. Warner, Westville..... F. M. Cole & Co., Putnam	28.00 27.00	16.75
14533	E. F. Coe's Columbian Corn Fertilizer	E. Frank Coe Co., N. Y.	Young Bros. Co., Danielson..... J. W. Gardner, Cromwell	26.00 30.00	17.65
14414	Mapes' Fruit and Vine	Mapes F. & P. G. Co., N. Y.	A. L. Burdick, Westbrook	27.00 28.50	
14512	Quinnipiac Potato Phosphate	American Agricultural Chemical Co., N. Y.	Mapes' Branch, Hartford	39.00	24.04
			Young Bros. Co., Danielson	30.00	18.99
			G. M. Williams Co., New London	32.00 31.00	

ANALYSES AND VALUATIONS—*Continued.*

Station Number.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.						POTASH.		
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.	
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Murate.	Guaranteed.
14254	56.7	0.34	---	1.92	2.26	2.1	3.31	4.81	2.64	10.76	10.0	8.12	8.0	5.78	6.0
14222	57.5	0.36	---	2.31	2.67	2.5	4.88	2.33	1.26	8.47	7.0	7.21	6.0	5.40	5.0
14251	57.8	0.84	---	1.86	2.70	2.5	4.42	2.70	1.62	8.74	7.0	7.12	6.0	5.53	5.0
14333	58.0	1.28	0.42	0.70	2.40	2.5	4.00	5.82	1.40	11.22	10.0	9.82	8.0	6.54	6.0
14525	58.2	0.33	---	2.01	2.34	2.1	5.63	3.22	2.23	11.08	9.0	8.85	8.0	2.00	1.5
14473	58.9	---	---	1.85	1.85	1.6	3.52	4.39	1.56	9.47	10.0	7.91	8.0	3.34	4.0
14377	59.0	---	0.25	1.77	2.02	1.7	4.06	4.09	1.96	10.11	9.0	8.15	7.0	2.92	2.0
14508	59.9	0.20	---	1.99	2.19	2.1	5.04	3.42	2.23	10.69	9.0	8.46	8.0	1.89	1.5
14497	61.2	---	---	1.54	1.54	0.8	6.64	1.47	2.25	10.36	9.0	8.11	7.5	0.86	3.0
14533	61.5	---	---	1.69	1.69	1.2	6.50	1.92	2.25	10.67	10.5	8.42	8.5	0.51	2.5
14414	62.2	1.16	0.38	0.59	2.13	1.6	1.84	4.20	1.48	7.52	7.0	6.04	5.0	1.92	10.0
14512	63.2	0.59	---	1.61	2.20	2.1	5.36	3.12	1.92	10.40	10.0	8.48	8.0	3.45	3.0

SPECIAL MANURES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	<i>1. Sampled by Station Agent:</i>				
14504	Crocker's Potato, Hop and Tobacco..	American Agricultural Chemical Co., N. Y.	W. L. Wellwood, So. Coventry	\$32.00	\$18.87
14488	Packers' Union Potato Manure.....	American Agricultural Chemical Co., N. Y.	F. M. Loomis, North Granby.....	31.00	
14520	Mapes' Cereal Brand	Mapes F. & P. G. Co., N. Y.	G. A. Forsyth, Waterford	32.00	19.28
14273	Bradley's Corn Phosphate	American Agricultural Chemical Co., N. Y.	E. T. Tillinghast, Danielson	32.00	
14509	Great Eastern Northern Corn Special	American Agricultural Chemical Co., N. Y.	Mapes' Branch, Hartford	28.00	16.82
14503	Williams & Clark's Potato Manure	American Agricultural Chemical Co., N. Y.	W. H. H. Chappell, R. F. D., Oakdale..	32.00	19.17
14221	Bowker's Potato and Vegetable Phosphate	Bowker Fertilizer Co., N. Y.	F. S. Bidwell & Co., Windsor Locks....	32.00	
14526	Grass and Lawn Top Dressing	American Agricultural Chemical Co., N. Y.	R. H. Hall, East Hampton	34.00	20.32
14388	Darling's Potato Manure	American Agricultural Chemical Co., N. Y.	S. A. Post, Westbrook	34.00	
14534	Essex Corn Fertilizer	Russia Cement Co., Gloucester, Mass..	D. B. Wilson & Co., Waterbury.....	32.00	19.09
14499	Wheeler's Bermuda Onion Grower	American Agricultural Chemical Co., N. Y.	Carlos Bradley, Ellington	32.00	
14501	Bowker's Potato and Vegetable Fertilizer	Bowker Fertilizer Co., N. Y.	Lightbourn & Pond Co., New Haven..	30.00	17.87
14295	New England Potato Fertilizer	New England Fertilizer Co., Boston....	Bowker's Branch, Hartford	30.00	
14535	Grass and Oats Fertilizer	American Agricultural Chemical Co., N. Y.	T. B. Atwater, Plantsville	37.00	21.90
			H. F. Cady, Stafford	34.00	20.54
			T. S. Loomis, Windsor	36.00	
			W. J. Cox, East Hartford	35.00	
			J. B. Parker, Poquonock	34.00	19.57
			W. H. Baldwin, Cheshire	33.50	
			G. F. Walter, Guilford.....	28.00	16.16
			A. R. Manning, Yantic	37.00	21.34
			Rockville Milling Co., Rockville	31.00	17.21
			E. F. Miller, Ellington	30.00	
			J. H. Paddock, Wallingford	30.00	
			H. F. Porter, Hebron	20.00	11.83
				22.00	
				21.00	

ANALYSES AND VALUATIONS—*Continued.*

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.						POTASH.			
		As Nitrate.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	As Murate.	Total.			
14504	64.3	0.32	---	1.80	2.12	2.1	6.11	2.68	2.02	10.81	9.0	8.79	8.0	3.14	3.14	3.0
14488	65.9	0.28	0.22	1.58	2.08	2.1	1.54	5.75	3.71	11.00	10.0	7.29	8.0	4.99	4.99	6.0
14520	66.5	0.89	0.43	0.68	2.00	1.6	3.12	4.26	2.09	9.47	8.0	7.38	6.0	3.18	3.18	3.0
14273	66.9	0.20	---	2.20	2.40	2.1	5.74	3.38	2.28	11.40	9.0	9.12	8.0	1.85	1.85	1.5
14509	67.3	0.71	---	1.80	2.51	2.5	5.81	3.71	2.07	11.59	11.0	9.52	9.0	2.61	2.61	2.0
14503	67.6	0.29	---	1.90	2.19	2.1	5.50	3.18	2.07	10.75	9.0	8.68	8.0	3.23	3.23	3.0
14221	67.9	0.36	---	1.50	1.86	1.7	7.28	2.77	1.14	11.19	10.0	10.05	9.0	2.20	2.20	2.0
14526	68.9	1.48	1.11	1.18	3.77	3.9	1.41	5.87	1.23	8.51	6.0	7.28	5.0	2.53	2.53	2.0
14388	70.4	0.36	0.47	1.65	2.48	2.5	4.99	2.98	1.50	9.47	7.0	7.97	6.0	4.81	4.81	5.0
14534	71.2	0.38	---	1.82	2.20	2.0	3.65	5.17	3.82	12.64	11.0	8.82	8.5	3.05	3.05	3.0
14499	73.1	----	---	1.13	1.13	0.8	7.26	2.05	2.01	11.32	9.0	9.31	8.0	3.57	3.57	4.0
14501	73.4	0.67	---	2.02	2.69	2.5	7.04	1.33	0.69	9.06	9.0	8.37	8.0	4.60	4.60	4.0
14295	74.3	----	---	1.63	1.63	1.6	5.76	2.36	0.84	8.96	8.0	8.12	7.0	4.43	4.43	4.0
14535	76.8	----	---	---	---	---	6.30	4.27	2.47	13.04	12.0	10.57	11.0	2.12	2.12	2.0

SPECIAL MANURES.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.	Valuation per ton.
	<i>1. Sampled by Station Agent:</i>				
14532	E. F. Coe's Columbian Potato Fertilizer	E. Frank Coe Co., N. Y.	J. W. Gardner, Cromwell Balch & Platt, West Winsted	\$30.00 32.00 31.00	\$17.40
14521	Wheeler's Corn Fertilizer	American Agricultural Chemical Co., N. Y.	J. R. Morgan, Bethel	32.00	17.86
14530	New England Corn Phosphate	New England Fertilizer Co., Boston	A. R. Manning, Yantic	31.00	17.21
14187	Swift's Lowell Potato Manure	Swift's Lowell Fertilizer Co., Boston	Standard Feed Co., Bridgeport F. S. Bidwell & Co., Windsor Locks	30.00 32.00 31.00	16.84
14563	Read's Practical Potato Special	American Agricultural Chemical Co., N. Y.	J. A. Nichols, Danielson J. G. Schwink, Meriden L. A. Fenton, Norwich Town	32.00 29.00 30.00 30.25 33.00 30.00 31.50	15.96
14202	Bowker's Corn Phosphate	Bowker Fertilizer Co., N. Y.	G. F. Walter, Guilford Bishop & Lynes, Norwalk	33.00 30.00 31.50	16.50
14372	New England Corn and Grain Fertilizer	New England Fertilizer Co., Boston	A. R. Manning, Yantic Rockville Milling Co., Rockville	28.00 28.00	14.61
	<i>2. Sampled by Purchasers and others.</i>		<i>Sent by</i>		
15125	Sanderson's Formula B for Tobacco	Sanderson Fertilizer & Chemical Co., New Haven	Geo. S. Champlin, Ashaway, R. I.	32.00	31.14
14551	Hubbard's Soluble Tobacco Manure	The Rogers & Hubbard Co., Middletown	Arthur Brown, Hillstown	42.50	36.35
14059	Rogers' Tobacco Manure	The Rogers Mfg. Co., Rockfall	Jas. H. Wilson, Poquonock	44.00	37.09
14209	Sanderson's Formula B for Tobacco	Sanderson Fertilizer & Chemical Co., New Haven	Wm. W. Thompson, Warehouse Point	34.00	26.95
14553	Hubbard's Soluble Potato Manure	The Rogers & Hubbard Co., Middletown	Arthur Brown, Hillstown	40.00	31.50
14550	Tobacco Starter and Grower	American Agricultural Chemical Co., N. Y.	Arthur Brown, Hillstown	34.00	24.65
14542*	Shay's Grass Fertilizer	C. M. Shay Fertilizer Co., Groton	Manufacturer	35.00	23.52
14554	Special Potato	E. Frank Coe Co., N. Y.	Arthur Brown, Hillstown	34.00	19.08

* See notice on page 72.

ANALYSES AND VALUATIONS—*Concluded.*

Station No.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.								POTASH.		
		As Nitrates.	As Ammonia.	Organic.	Total Nitrogen.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Found.	As Muriate.	Total.	Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.				
14532	78.2	----	----	1.50	1.50	1.0	6.88	2.14	2.62	11.64	10.0	9.02	8.5	0.32	2.95	2.5	
14521	79.2	----	----	2.01	2.01	1.7	6.48	2.29	1.78	10.55	9.0	8.77	8.0	2.41	2.41	2.0	
14530	80.1	----	----	1.80	1.80	1.8	5.92	2.73	0.94	9.59	9.0	8.65	8.0	3.13	3.13	3.0	
14187	84.1	----	----	1.73	1.73	1.7	4.96	2.65	1.14	8.75	8.0	7.61	7.0	4.00	4.00	4.0	
14563	89.5	0.03	---	0.93	0.96	0.8	3.57	2.38	1.34	7.29	5.0	5.95	4.0	7.97	7.97	8.0	
14202	90.9	0.64	---	1.24	1.88	1.7	5.78	2.35	0.99	9.12	9.0	8.13	8.0	2.65	2.65	2.0	
14372	91.6	----	----	1.41	1.41	1.2	5.44	2.65	0.89	8.98	8.0	8.09	7.0	2.36	2.36	2.0	
15125	2.8	0.84	---	2.63	3.47	3.3	0.67	6.77	2.53	9.97	10.0	7.44	6.0	1.85	6.37	6.0	
14551	16.9	2.72	0.38	1.82	4.92	5.0	0.86	8.01	3.30	12.17	10.0	8.87	7.0	1.37	10.75	10.0	
14059	18.6	1.84	0.22	3.23	5.29	----	1.95	6.57	1.11	9.63	----	8.52	----	1.06	10.81	----	
14209	26.3	0.98	---	2.73	3.71	3.3	0.93	5.91	4.78	11.62	10.0	6.84	6.0	1.62	6.26	6.0	
14553	27.0	2.51	0.24	2.12	4.87	5.0	0.88	7.68	5.13	13.69	10.0	8.56	7.0	1.17	5.49	5.0	
14550	37.9	----	1.34	1.64	2.98	3.3	7.25	2.16	2.83	12.24	9.0	9.41	8.0	0.51	4.58	4.0	
14542	48.8	1.17	0.09	1.77	3.03	3.0	3.60	4.54	3.60	11.74	8.0	8.14	----	5.13	5.13	5.0	
14554	78.2	----	----	2.02	2.02	1.7	6.35	1.68	1.55	9.58	10.0	8.03	8.0	0.49	4.00	4.0	

TOBACCO FERTILIZERS CONTAINING CARBONATES.

Station No.	Name or Brand.	Manufacturer.	Dealer or Purchaser.
4438	Complete Tobacco Manure	American Agricultural Chemical Co., New York	E. N. Austin, Suffield T. S. Loomis, Windsor O. S. Olmstead, Melrose Broad Brook Lumber Co. Broad Brook S. J. Stevens, Glastonbury
4552	Complete Tobacco Manure	American Agricultural Chemical Co., New York	Arthur Manning, ¹ Hillstown
5880	" " "	American Agricultural Chemical Co., New York	S. J. Stevens, Glastonbury Alfred Weldon, " Seth Viets, ² Suffield J. B. Parker, Poquonock
4440	Bowker's Complete Alkaline Tobacco Grower	Bowker Fertilizer Co., New York	Bowker's Branch, Hartford
3415	Bowker's Tobacco Carbonates	Bowker Fertilizer Co., New York	James R. Hayes & Son, ² Granby Newell St. John, Simsbury Seth Viets, ² Suffield J. B. Parker, Poquonock
4292	" " "	Bowker Fertilizer Co., New York	Bowker's Branch, Hartford
4439	" " "	Bowker Fertilizer Co., New York	James R. Hayes & Son, ² Granby Newell St. John, Simsbury Seth Viets, ² Suffield J. B. Parker, Poquonock
3414	Bowker's Tobacco Ash Elements	Bowker Fertilizer Co., New York	Bowker's Branch, Hartford
6026	Bowker's Tobacco Ash Elements	Bowker Fertilizer Co., New York	Seth Viets, ² Suffield
4441	Mapes' Tobacco Manure (Wrapper Brand)	Mapes F. & P. G. Co., N. Y.	J. B. Parker, Poquonock T. S. Loomis, Windsor O. S. Wood, Ellington Spencer Bros., Suffield Mapes' Branch, Hartford
4442	Mapes' Tobacco Ash Constituents	Mapes F. & P. G. Co., N. Y.	Mapes' Branch, Hartford Spencer Bros., Suffield
4194	Mapes' Tobacco Starter, Improved	Mapes F. & P. G. Co., N. Y.	Spencer Bros., Suffield Mapes' Branch, Hartford
4453	Special Tobacco Manure with Carbonate Potash	National Fertilizer Co., Bridgeport	J. N. Lasbury, Broad Brook
4223	O. & W's. Complete Tobacco Fertilizer	Olds & Whipple, Hartford	A. A. & W. G. Forbes, Silver Lane
4224	O. & W's. Complete Tobacco Fertilizer	" " " "	P. S. Brewer, Silver Lane
4229	O. & W's. Complete Tobacco Fertilizer	" " " "	Wm. H. Brewer, Silver Lane
4378	O. & W's. Complete Tobacco Fertilizer	" " " "	Patrick Connor, Poquonock
4444	O. & W's. Complete Tobacco Fertilizer	" " " "	L. A. Kent, Suffield G. F. King, " Samuel Orr, " J. F. Adams, " H. L. Spear, " L. W. Allen, " D. F. Remington, Suffield Spencer Bros., Suffield Factory
4446	O. & W's. Complete Tobacco Fertilizer	" " " "	Joseph Watson, Enfield
4447	O. & W's. Complete Tobacco Fertilizer	" " " "	" " " "
4480	O. & W's. Complete Tobacco Fertilizer	" " " "	John Lavery, Poquonock

pled and sent by Arthur Brown, Hillstown.
pled and sent by Alfred H. Griffin, Granby.

² Purchased by Julius Moore, Suffield
⁴ Purchased by W. H. Hastings, Suffield

ANALYSES AND VALUATIONS.

NITROGEN.					PHOSPHORIC ACID.						POTASH.						Sulphuric acid.	Cost per ton.	Valuation.	
Nitrogen as nitrates.	Nitrogen as ammonia.	Nitrogen organic.	Total.		Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.		So-called "Available."		Guaranteed.	Water-soluble.	Calculated as chloride.	Calculated as sulphate.	Calculated as carbonate.				Chlorine.
			Found.	Guaranteed.				Found.	Guaranteed.	Total.	Guaranteed.									
---	---	4.79	4.79	4.5	0.00	5.10	3.41	8.51	4.0	5.10	3.0	5.5	5.22	1.45	2.27	1.50	1.09	1.93	\$33.00	\$29.00
																			36.00	
																			34.50	
																			35.00	
																			35.00	
---	---	4.91	4.91	4.5	none	6.19	1.40	7.59	4.0	6.19	3.0	5.5	3.69	0.74	2.40	0.55	0.56	2.04	35.50	27.00
---	---	4.48	4.48	4.5	0.22	6.14	1.41	7.77	4.0	6.36	3.0	5.5	5.16	1.00	2.11	2.05	0.75	1.79	----	28.00
---	---	4.49	4.49	4.0	0.00	7.40	5.07	12.47	5.0	7.40	4.0	5.0	4.63	0.35	2.20	2.08	0.26	1.87	34.00	30.00
																			33.00	
---	---	0.58	0.58	trace	trace	10.09	4.11	14.20	7.0	10.09	6.0	15.0	15.01	0.25	3.50	11.26	0.19	2.98	38.00	33.00
---	---	0.82	0.82	---	---	10.22	5.32	15.54	7.0	10.22	6.0	15.0	13.74	0.80	4.89	8.05	0.60	4.16	38.00	31.00
---	---	0.61	0.61	---	0.00	9.55	3.24	12.79	7.0	9.55	6.0	15.0	16.01	0.85	3.06	12.10	0.64	2.60	38.00	34.00
																			38.00	
																			38.00	
---	---	0.65	0.65	trace	none	11.11	4.50	15.61	7.0	11.11	6.0	15.0	14.74	0.55	14.19	----	0.41	16.96	32.00	27.00
---	---	0.64	0.64	---	0.00	10.00	4.26	14.26	7.0	10.00	6.0	15.0	15.36	0.65	14.71	----	0.49	16.63	30.50	27.00
																			30.50	
																			31.00	
65	---	1.85	6.50	6.2	0.00	4.67	1.29	5.96	4.5	4.67	---	10.5	11.08	2.11	2.54	6.43	1.59	2.16	46.00	41.00
																			48.00	
																			47.00	
05	---	0.61	0.66	0.5	0.00	1.21	5.08	6.29	5.7	1.21	---	15.0	15.70	3.36	12.34	----	2.53	12.42	32.00	20.00
																			33.00	
12	0.50	1.91	4.53	4.1	2.21	4.96	1.96	9.13	8.0	7.17	6.0	1.0	2.46	1.28	1.18	----	0.96	----	36.00	24.00
																			35.00	
---	---	4.68	4.68	4.5	0.11	5.03	0.62	5.76	4.0	5.14	3.0	5.5	5.05	0.80	1.69	2.56	0.60	1.44	31.00	28.00
37	---	4.03	5.40	4.5	0.38	3.50	0.65	4.53	---	3.88	3.0	5.5	6.46	0.53	2.54	3.39	0.40	2.16	34.00	31.00
33	---	4.00	5.33	4.5	0.37	3.40	0.64	4.41	---	3.77	3.0	5.5	6.41	0.53	2.68	3.20	0.40	2.28	34.00	30.00
00	---	4.20	5.20	4.5	0.34	3.56	0.83	4.73	---	3.90	3.0	5.5	5.64	0.39	2.26	2.99	0.29	1.92	34.00	29.00
29	---	4.53	4.82	4.5	0.38	4.69	1.75	6.82	---	5.07	3.0	5.5	5.55	1.00	2.96	1.59	0.75	2.52	35.00	28.00
44	0.28	4.23	4.95	4.5	0.48	5.04	1.73	7.25	---	5.52	3.0	5.5	5.49	0.86	2.26	2.37	0.65	1.92	36.00	30.00
																			36.00	
																			36.00	
																			36.00	
																			36.00	
																			36.00	
																			36.00	
																			35.00	
																			35.00	
56	0.22	4.09	4.87	4.5	0.48	5.58	1.82	7.88	---	6.06	3.0	5.5	5.67	1.12	2.11	2.44	0.84	1.79	35.00	30.00
72	0.17	4.42	5.31	4.5	0.32	5.00	1.46	6.78	---	5.32	3.0	5.5	6.10	1.00	2.20	2.90	0.75	1.87	35.00	31.00
---	0.24	4.59	4.83	4.5	0.50	3.47	1.28	5.25	---	3.97	3.0	5.5	5.69	1.29	2.43	1.97	0.97	2.07	36.00	28.00

HOME MIXTURES. FORMULAS,

Station No.	Made by	FORMULAS. POUNDS PER TON						
		Nitrate of Soda.	Dried Blood.	Castor Pomace.	Dry Fish.	Tankage.	Ground Bone.	Dissolved Bone Black. Acid Phosphate. Mixture of Fish.
13968	Andrew Ure, Highwood, Special Mixture	---	---	---	---	---	---	---
14125	J. G. Schwink, Meriden	100	---	---	---	750	---	750 25
14225	A. C. Lake, Watertown	140	---	---	---	780	---	650 45
14285	Conn. School for Boys, Meriden, Grass Mixture	500	---	---	---	500	---	400 25
14286	" " " " Potatoes	100	---	---	---	750	---	750 200
14305	W. B. Thrall, Rockville	100	---	---	---	750	---	750
14394	W. H. Baldwin, Cheshire	---	---	---	---	---	---	---
14556	Arthur Manning, Hillstown	600	---	700	700	---	---	---
14558	Barnes Bros., Yalesville	150	850	---	---	---	---	900 100
15124	Andrew Kingsbury, Coventry	375	---	---	---	---	400	600

HOME MIXTURES.

In the table given above are analyses of ten home-mixtures which were in most cases sampled and sent by the persons who made them. Sample 14305 was mixed for the purchaser by a fertilizer company according to a formula furnished by him.

The same is true of sample 14558.

The cost given does not in most cases cover the cost of mixing, but includes freight to owner's freight station.

These mixtures have a wide range of composition, to be sure, but the average of the nine whose cost is known is

Nitrogen	4.21 per cent.
Phosphoric acid	9.27
Potash	7.27
Cost per ton	\$27.69

If we reckon the cost of mixing at \$2.31, a very liberal figure, it appears that in the home-mixtures \$30.00 bought 84 pounds of nitrogen, 185 pounds of phosphoric acid and 145 pounds of potash. This is more than could be bought for the same money in the highest grade factory mixed superphosphates or special manures, as may be seen by comparing these figures with those given on pages 54 and 75.

ANALYSES AND VALUATIONS.

OF MIXTURES.			ANALYSES.									COST (UNMIXED) AND VALUATION.	
Double Sulphate of Potash.	Salt-peter Waste.	Kalnit.	Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.	Water-soluble Phosphoric Acid.	Citrate-soluble Phosphoric Acid.	Citrate-insoluble Phosphoric Acid.	Total Phosphoric Acid.	Potash.	Cost per ton.	Valuation per ton.
---	---	---	0.59	---	2.09	2.68	3.42	2.71	1.67	7.80	4.32	-----	\$19.33
200	---	---	1.13	---	2.39	3.52	3.78	4.83	1.64	10.25	8.63	\$25.00	28.33
---	---	---	0.96	---	2.86	3.82	4.59	5.10	1.12	10.81	11.03	27.84	31.88
---	350	---	3.79	---	1.67	5.46	1.92	3.25	0.68	5.85	9.49	28.37	31.74
200	---	---	0.64	---	2.57	3.21	3.14	5.11	1.82	10.07	8.51	23.35	26.76
400	---	---	0.89	---	1.81	2.70	4.88	2.53	6.02	13.43	4.90	28.25	23.17
---	---	---	---	---	1.48	1.48	8.43	2.67	1.05	12.15	7.57	24.00	22.06
---	---	---	5.12	---	4.07	9.19	0.26	1.42	0.26	1.94	1.05	35.08	34.88
---	---	---	0.91	---	4.32	5.23	6.08	1.69	0.81	8.58	2.66	28.83	28.47
625	---	---	3.15	---	0.13	3.28	3.30	6.14	0.92	10.36	11.65	26.02	29.34

VEGETABLE POTASH.

This material, sold by Olds & Whipple, Hartford, is stated to be the ashes of refuse from beet sugar factories.

14131. Sampled and sent by E. S. Seymour, Windsor Locks, from stock of Olds & Whipple.

14436. Sampled by station agent from stock of J. C. Eddy, Simsbury, Olds & Whipple, Hartford and D. F. Remington, Suffield.

ANALYSES.

	14131	14436
Water-soluble potash	25.19	24.84
Total potash	26.44	....
Chlorine	2.25	2.25
Sulphuric acid	2.25	2.21
Cost per ton	\$40.00	40.00
Water-soluble potash costs cents per pound...	7.9	8.1

Most of the potash in this material is in form of carbonate.

COTTON HULL ASHES.

This material is the ashes of the hulls which are separated from the "meats" of the cotton seed preliminary to the expression of cotton seed oil. For a time these ashes were abundant

in our market and much prized as a potash fertilizer for tobacco. Then, for a few years, they could not be obtained, but during 1905 a considerable amount has been brought into this state.

Eighteen analyses have been made during 1905 which appear in the following table, together with one analysis of so-called "cotton-boll ashes," which have a similar composition.

14050. Car of 30 tons sold to Bissell-Graves Co., Suffield, **14047**, car of 20 tons sold to Henry Adams, J. F. Merrill and others, Suffield; **14040**, 3 tons sold to Edmund Halladay, Suffield. The three lots sold by Arthur Sikes of Suffield.

14280. Bought of Humphreys, Godwin & Co., Memphis, Tenn. Sampled and sent by H. S. Chapman & Co., Suffield.

14049. Car of 20 tons sold to W. H. Prout and others, Suffield; **14048**, car of 20 tons sold to W. H. Prout, D. I. King and others, Suffield; **14184**, sampled and sent by W. H. Prout, Suffield; **14211**, car of 15 tons sold to G. E. Gompf, J. S. Gardner and A. R. Austin, Suffield; **14258**, car of fifteen tons sold to Oscar Hazard and others of Suffield; **14261**, six tons sold to C. K. and H. T. Hale, Gildersleeve. The six lots from stock of Arthur Sikes, Suffield.

14399. Sampled by station agent from stock of C. K. Hale, Gildersleeve, bought of Arthur Sikes, Suffield.

14243. Sampled and sent by O. G. Hazard from stock bought of Arthur Sikes, Suffield.

14260. Car of 15 tons sold to John Sullivan and G. A. Peckham of Suffield; L. M. Pomeroy, West Suffield, and J. B. Cannon, Granby; **14259**, car of 15 tons sold to G. N. Thompson, Suffield, and others. The two lots from stock of Arthur Sikes, Suffield, and sampled by him.

14544. Bought of Humphreys, Godwin & Co., Memphis, Tenn., sampled and sent by Arthur Sikes, Suffield.

12991. "Cotton Boll Ashes" from American Cotton Oil Co., Memphis, Tenn., sampled and sent by Spencer Bros., Suffield.

13830. Sold by American Cotton Oil Co., 27 Beaver St., New York. Sampled and sent by Spencer Bros., Suffield.

13930. Sampled and sent by Arthur Sikes, Suffield.

14080. Sampled and sent by H. C. Warner, West Suffield, from stock of W. F. Fletcher, Southwick, Mass.

The percentage of water-soluble potash ranges from 12.64 to 23.61 and averages 19.80. Four of the samples are decidedly

ANALYSES OF COTTON HULL ASHES.

Station No.	PHOSPHORIC ACID.				POTASH.		Sulphuric Acid.	Chlorine.	Cost per ton.	Potash costs cents per pound.
	Water-soluble.	Citrate-soluble.	Citrate-insoluble.	Total.	Total.	Water-soluble.				
14050	0.19	7.88	0.71	8.78	26.91	22.72	2.94	0.30	\$41.00	7.2
14047	0.45	7.15	0.66	8.26	26.84	23.61	2.81	0.21	41.00	7.3
14040	0.20	7.30	0.75	8.25	27.17	23.45	2.90	0.22	41.00	7.4
14280	1.28	6.21	0.95	8.44	22.60	20.60	2.68	0.19	38.00	7.6
14049	0.37	8.12	0.68	9.17	27.04	22.01	2.72	0.24	41.00	7.7
14048	0.19	7.38	0.66	8.23	26.33	22.15	2.90	0.27	41.00	7.8
14184	0.26	7.69	0.49	8.44	27.00	21.84	3.85	0.28	41.00	7.9
14211	1.17	5.69	0.76	7.62	14.92	12.64	1.92	0.07	27.50	8.5
14261	1.31	6.30	0.90	8.51	22.16	20.00	2.75	0.09	41.00	8.6
14258	1.33	5.77	0.93	8.03	21.74	19.96	2.77	0.15	41.00	8.7
14399	0.93	6.50	0.90	8.33	21.94	19.72	2.89	0.11	41.00	8.8
14243	1.25	5.79	0.97	8.01	22.03	19.50	2.73	0.11	41.00	8.9
14260	0.97	6.51	0.93	8.41	21.68	19.36	2.92	0.08	41.00	8.9
14259	1.18	6.00	0.73	7.91	21.28	19.22	2.56	0.08	41.00	9.0
14544	1.04	5.61	1.38	8.03	21.04	19.38	2.86	0.30	41.00	9.0
12991*	0.27	6.36	0.62	7.25	24.84	21.28	3.20	0.15	45.00	9.2
13830	0.75	5.20	0.55	6.50	17.03	15.00	3.44	0.12	34.32	9.8
13930	0.45	7.26	0.59	8.30	20.22	17.40	2.26	0.20	41.00	9.9
14080	0.96	7.30	0.66	8.92	20.90	16.40	1.67	0.07	44.00	11.3

* Cotton-boll ashes.

inferior as respects their potash content, but there is no evidence that they are adulterated. In some of the samples less than two per cent. of the total potash is insoluble in water, while in others over five per cent. is insoluble. The solubility of the potash is affected by the heat to which the hull ashes are subjected in the furnaces and by accidental impurities like sand, which may be there. If ashes are heated sufficiently with sand the potash may unite with sand and silicates to make compounds which are only very slowly and incompletely soluble in water, but which are broken up by acids.

Valuing the phosphoric acid in these samples as in mixed fertilizers, the cost of potash, which is largely in form of carbonate, ranges from 7.2 cents to 11.2 cents per pound, the average being 8.55 cents or 1.5 cents more per pound than in high grade carbonate, as appears on page 37.

WOOD ASHES.

In the table, pages 102 and 103 are given twenty-one analyses of "wood ashes" which show the usual range of composition.

WOOD ASHES.

Station No.	Dealer or Purchaser.	Sampled or Sent by.
	<i>Bowker Fertilizer Co., New York—</i>	
14183	W. T. McKenzie, Yalesville.	F. Seth Wiard, Yalesville
14242	Robert Hubbard, Middletown	Robert Hubbard
14311	Seth Viets, Suffield	Herman Ude, Suffield
14400	Barnes Bros., Yalesville	Barnes Bros.
14402	Seth Viets, Suffield	Station agent (stock of H. L. Spear)
14559	E. F. Jennison, Hartford	Barnes Bros., Yalesville
	<i>John Joynt, Lucknow, Ont.—</i>	
13998	J. G. Whitney, New Canaan.	J. G. Whitney
14241	G. E. Norton, Bristol	G. E. Norton
14309	Ernest N. Austin, Suffield ...	Ernest N. Austin
14401	H. C. Aborn & Son, Ellington	Station Agent
	F. S. Bidwell, Windsor Locks	
15127	J. Arthur Sherwood, R. F. D. 5, Long Hill	J. Arthur Sherwood
15919	I. C. Fanton, Westport	I. C. Fanton
	<i>F. R. Lalor, Dunnville, Ont.—</i>	
13405	J. H. Elwood, Greens Farms	Station Agent
14128	Thos. Holt, Southington	Thomas Holt
	<i>Geo. L. Monroe & Sons, Oswego, N. Y.—</i>	
15191	Herbert Barnes, 1212 Quin-niac Ave., New Haven....	Herbert Barnes
14082	F. S. Bidwell, Windsor Locks	Ernest N. Austin, Suffield
14310	H. K. Brainard, Thompsonville	G. A. Douglass, Thompsonville.
	<i>Chas. Stevens—</i>	
13847	Wm. H. Wilson, Harwinton	Wm. H. Wilson
14545	P. Havey, Suffield	P. Havey
13813	Chase Rolling Mill, Waterbury	W. M. Shepardson, Middlebury
14293	W. H. H. Miller, Glastonbury	W. H. H. Miller

The percentage of total potash ranges from 6.91 to 3.35 and that of lime from 50.05 to 26.51.

The last one given in the table, which is excluded from the averages, is apparently leached ashes.

The average composition of the ashes is:—

Total potash	5.08
Water-soluble potash	4.40
Phosphoric acid	1.39
Lime	32.98
Cost per ton	\$10.37

If water-soluble potash is valued at eight cents per pound and phosphoric acid at four cents, the lime in ashes of average composition costs about 34 cents per 100 pounds.

PERCENTAGE COMPOSITION.

Total potash.	Potash solub in water.	Phosphoric acid.	Lime.	Magnesia.	Chlorine.	Sand and soil.	Charcoal.	Sulphuric acid.	Cost per ton.
5.37	4.57	1.83	28.40	-----	-----	-----	-----	-----	\$10.00
5.73	4.93	1.27	31.64	-----	-----	-----	-----	-----	9.50
5.45	4.66	1.51	33.54	-----	-----	-----	-----	-----	10.00
6.74	5.72	1.69	33.39	-----	-----	-----	-----	-----	11.00
4.90	4.28	1.36	33.50	-----	-----	-----	-----	-----	11.00
3.71	3.28	1.32	31.06	-----	-----	-----	-----	-----	11.00
3.78	3.14	1.32	31.21	-----	trace	-----	-----	-----	11.75
5.13	4.49	1.24	29.72	-----	-----	-----	-----	-----	9.50
6.02	4.73	1.60	26.51	-----	-----	-----	-----	-----	12.00
6.90	6.28	1.41	28.37	-----	-----	-----	-----	-----	11.00
				-----	-----	-----	-----	-----	12.00
3.35	2.87	0.84	37.62	-----	-----	-----	-----	-----	10.50
4.38	3.17	1.33	-----	-----	-----	25.50	4.31	1.48	9.25
3.83	3.47	1.22	34.92	-----	-----	-----	-----	-----	9.00
5.34	5.05	1.40	38.54	-----	-----	-----	-----	-----	9.25
3.95	3.28	1.23	30.42	-----	-----	-----	-----	-----	9.50
5.22	4.70	1.30	36.03	-----	-----	-----	-----	-----	10.00
4.44	3.74	0.92	29.67	-----	-----	-----	-----	-----	10.50
6.33	5.70	1.74	50.05	2.46	trace	-----	-----	0.69	-----
6.91	6.31	1.54	26.80	-----	-----	-----	-----	-----	-----
4.05	3.65	1.73	35.26	-----	-----	-----	-----	-----	-----
-----	1.85	-----	37.21	-----	-----	-----	-----	-----	-----

LIME KILN ASHES.

14083. Sampled and sent by E. N. Austin, Suffield.

14403. Sold by New England Lime Co., Canaan. Sampled by station agent from stock of M. E. Thompson, Ellington.

ANALYSES OF LIME KILN ASHES.

	14083	14403
<i>Percentage amounts of</i>		
Total potash	2.94	2.80
Water-soluble potash	2.56	2.41
Lime	35.50	42.85
Phosphoric acid	1.02	1.22
Cost per ton	\$6.00	8.50
Lime costs cents per 100 pounds*.....	.15	.43

* Valuing water-soluble potash at 8 cents and phosphoric acid at 4 cents per pound.

LIME.

Two samples of unslaked lime, **15916** and **15920**, sent for analysis by P. D. Kibbe, Hartford, are stated to be from stock of Olds & Whipple, Hartford and sell for \$9.00 and \$8.00 per ton respectively.

ANALYSES.

	15916	15920
Insoluble in acid	2.52	2.28
Lime	46.09	47.28
Magnesia	32.70	33.81

Both samples are made from magnesian limestone such as occurs in the western part of this state. The lime in them costs about 85 cents per 100 pounds; lime and magnesia together cost about 50 cents per 100 pounds.

SOUTH AMERICAN GUANO.

No. **14405**. Sampled and sent by E. P. Brewer, Silver Lane, was stated by the Philadelphia firm selling it to contain 13 per cent. of ammonia, (equivalent to 10.7 per cent. of nitrogen,) 5 of "available" phosphoric acid and 2 of potash.

ANALYSIS OF SOUTH AMERICAN GUANO.

Percentage amounts of

Nitrogen, organic	10.94
Water-soluble phosphoric acid	2.08
Citrate-soluble phosphoric acid	1.44
Citrate-insoluble phosphoric acid	0.19
Total potash	1.59
Water-soluble potash	0.84

A guano composed of the excrement of birds contains a considerable part of its nitrogen in form of ammonia and is soluble and very quickly available to plants. This material, however, contains no ammonia, the microscope shows it to be full of insect residues and it is probably a bat guano. The nitrogen in such material comes largely from insect wings and wing cases and is as inert in the soil as hair. Its purchase for use as a fertilizer cannot under ordinary circumstances be advised.

SWEEPINGS FROM A FERTILIZER FACTORY.

No. **14289**, sent by T. G. Whipple, Mystic, had the following composition.

Percentage amounts of

Nitrogen as nitrate	0.24
Nitrogen, organic	1.04
Water-soluble phosphoric acid	3.71
Citrate-soluble phosphoric acid	2.08
Citrate-insoluble phosphoric acid	0.45
Water-soluble potash	1.48
Cost per ton	\$19.00
Valuation per ton	11.11

DUST FROM WHEAT.

Sample No. 14182, from the Ready Bits factory in New Haven, sampled by the station agent, contained 2.08 per cent. of nitrogen.

PULVERIZED SHEEP MANURE.

Sample No. 14127, sent by the Stafford Floral Co., contained 2.42 per cent. of nitrogen.

ROTTED COTTON SEED COMPOST.

Sample 13410, sent by the Bissell Graves Co., Suffield, contained 1.70 per cent. of nitrogen, 0.61 of phosphoric acid and 0.93 per cent. of potash. Its value as a commercial fertilizer is very small.

DUST FROM TOBACCO STEMMED BY MACHINERY.

Sample 14406, sent by J. & H. Woodford, Avon, contained nitrogen 2.07 per cent., phosphoric acid 0.45 per cent., potash 1.86 per cent. This material, finely powdered, would serve as an insecticide for sucking insects, lice, etc., in the garden and incidentally as a fertilizer.

CARPET WOOL.

12990 is a sample of carpet shearings sent by C. H. Brainard, Thompsonville. It could be delivered on the land for about \$2.50 per ton. The sample contained 13.88 per cent. of nitrogen. The nitrogen of wool waste is very inert, but may be made soluble by treatment with caustic soda. At the price named, which is equivalent to less than one cent per pound for nitrogen, it would be worth the experiment of composting with manure or other decaying matter.

SUMMARY.

The cash retail cost in Connecticut of nitrogen in raw materials during 1905 as shown in this report has been

	Highest.	Cents per pound. Lowest.	Average.
In Nitrate of soda	17.5	16.4	16.9
Dried blood .....	....	....	21.9
Cotton seed meal	20.6	14.2	16.4
Castor pomace	24.5	20.4	22.4
Flax seed meal .....	....	....	21.9

The corresponding price of "available" phosphoric acid in form of dissolved rock phosphate has been

4.8 4.3 4.5

The corresponding price of potash in raw materials has been

In High grade carbonate	7.3	6.7	7.1
Carbonate as "vegetable potash"...	8.1	7.9	8.0
High grade sulphate	5.3	4.8	5.0
Double sulphate	5.9	4.9	5.3
Muriate of potash	4.5	4.0	4.25
Saltpeter waste	..	..	0.7
Kainit	..	..	4.7

The price of lime *per 100 pounds* has been

In Wood ashes	..	..	34
Lime kiln ashes	15	4.3	..
Ground slaked lime	..	..	85

PART II.

TENTH

REPORT ON FOOD PRODUCTS.

NEW HAVEN, December 1, 1905.

To His Excellency, Henry Roberts, Governor of Connecticut:

As required by law, I herewith respectfully submit to you the Tenth Report of the Connecticut Agricultural Experiment Station on Food Products for the year ending July 31, 1905.

The work which has been done during the year is reported in the following pages, by Dr. Winton, chief of the chemical laboratory.

The station is charged only with the examination of food products, the publication of its findings and the report to the dairy commissioner of all cases of adulteration found. With the commissioner rests the enforcement of the law, and in his report will be found the record of prosecutions brought for violations of the law regarding food products.

It has hitherto been the practice of the station to examine gratuitously for private individuals the few samples of food products submitted by them, when accompanied with the required information regarding the origin of the samples. This was done with the belief that such examinations were, or might be, of general information and profit.

It has, however, become absolutely necessary to abandon this practice in large measure, in order that the station, with its present resources, may do the work required of it under various state laws. The number of samples sent in as above described had become very large, so that they very seriously interfered with our required work. (As will be seen in following pages, more than 260 samples of this kind were examined this year.) A part of the samples were from manufacturers or wholesalers, where no point of interest to the public was involved, and certain samples were found to have been sent merely for the purpose of deciding bets.

It is clear that, with the present public interest in the purity of food products, no institution with a yearly appropriation of \$2500 for the purpose, can carefully examine all the samples which the citizens of the state may care to send in for one reason or another. It is also clear that to accomplish most in stopping fraud in food, the matter of collecting food products for analysis should largely be left to the discretion of those specially charged with the work.

The station does not absolutely decline to examine any sample submitted by a purchaser or consumer, but in the public interest it has become necessary to strictly limit the amount of such work.

Very respectfully,

E. H. JENKINS, *Director*.

REPORT OF THE EXAMINATIONS OF FOOD PRODUCTS SOLD IN CONNECTICUT

In the year ending July 31, 1905.

BY A. L. WINTON, E. MONROE BAILEY, I. A. ANDREW,
AND KATE G. BARBER.

MILK.

Milk Sampled by the Station.—As in preceding years, all the samples here discussed were bought of milkmen during the summer months. The sampling agent visited fifteen towns and collected a total of 228 samples, all of which were analyzed in the station laboratory. The analysis included determinations of specific gravity, total solids, and fat (to detect skimmed milk or watered milk), tests for preservatives (boric acid, formaldehyde, etc.), and tests for foreign colors (coal-tar dyes, anatto, etc.).

A summary of the results is given in Table I, and the results in detail in Table II, pages 111-115.

From Table I it appears that of the 228 samples examined 78 were below standard in solids, 131 in solids not fat and 15 in fat. In all 134 failed to fully meet the standard requirements for market milk.

The following dealers sold milk which was grossly adulterated:

13763	Chas. Bahadoorigian, New Britain.....	Watered
13783	David Krall, New Haven.....	Formaldehyde
14583	A. Rice, New Haven (Montowese).....	Watered
13689	L. Burriesce, Stamford (Talmadge Hill).....	Watered

The following dealers sold milk which is below the United States standard and the station standard. The samples range from milk which is of poor quality in every particular all the way down to that which is unfit for sale on account of its chemical composition and is probably watered.

13721	J. E. Macdonald & Son, Bridgeport (Shelton).
14679	G. Winkler,* Derby.
14598	F. O. Jackson, Middletown.
14568	C. W. Brock, New Haven (Whitneyville).
14584	L. C. Palmer, New Haven.
14569	J. H. Story, New Haven.
13688	J. H. Bedell, Stamford.
13700	Emmet L. Weed, Stamford.
13746	T. B. Eggleston, Waterbury.
13753	W. Messick, Waterbury.
13750	Joseph Nagle,* Waterbury.
13748	F. C. Porter,* Waterbury.
13754	G. S. Van Atta, Waterbury.

There are also a dozen or more samples which, while they contain the percentage of fat necessary to meet the standard in that particular, are yet of very poor quality and some of them also are no doubt watered.

COMPOSITION OF MARKET MILK FOR THE LAST FIVE YEARS.

		Average Percentages.		Percentage of adulterated samples.
		Solids.	Fat.	
Summer	of 1905.....	12.36	4.04	1.8
"	" 1904.....	12.44	4.05	8.9
"	" 1902.....	12.63	4.13	10.9
"	" 1901.....	12.50	4.00	8.5
"	" 1900.....	12.53	3.99	11.4

Milk Sampled by the Dairy Commissioner.—Seventeen samples were examined, of which twelve were adulterated.

Milk Sampled by Health Officers.—On October 11, 1904, five sealed samples were received from G. W. Anderson, health officer, Stamford. All were of good quality excepting the following:

* As stated by driver.

13338. Marked: "Robt. Tryon, Roxbury." Contained formaldehyde.

Dr. E. A. McLellan, health officer, Bridgeport, sent the following on July 7, 1905.

14562. Stated to be market milk of Mr. Cole. Specific gravity at 60° F., 28.1; total solids, 10.82%; fat, 3.3%. Below standard.

TABLE I.—SUMMARY OF ANALYSES OF MILK BOUGHT OF MILKMEN, 1905.

Place.	Number of Samples.	Below twelve per cent. of total solids.	Below eight and one-half per cent. of solids not fat.	Below three and one-quarter per cent. of fat.	Contain boric acid (borax).	Contain formaldehyde.	Colored with anatto.	Colored with coal-tar dye.
Bridgeport	36	14	22	1	0	0	0	0
Derby	11	4	6	1	0	0	0	0
Glastonbury	2	0	0	0	0	0	0	0
Hartford	29	8	20	0	0	0	0	0
Middletown	19	3	8	1	0	0	0	0
New Britain	13	4	6	0	0	0	0	0
New Haven	35	20	27	3	0	1	0	0
New London	19	3	6	0	0	0	0	0
Norwalk	5	1	1	0	0	0	0	0
Norwich	13	4	6	1	0	0	0	0
South Glastonbury	1	0	1	0	0	0	0	0
South Norwalk	7	3	5	0	0	0	0	0
Stamford	16	6	10	3	0	0	0	0
Waterbury	12	7	10	5	0	0	0	0
Willimantic	10	1	3	0	0	0	0	0
Total for 1905 ..	228	78	131	15	0	1	0	0
" 1904 ..	316	108	185	31	2	5	5	2
" 1902 ..	292	80	130	22	1	3	4	3
" 1901 ..	375	109	190	43	2	7	--*	--*
" 1900 ..	246	54	100	34	7	14	--*	--*

* No tests for colors were made in 1900 and 1901.

The following sample was received on July 18, 1905, from Dr. Geo. T. Crowley, inspector of milk, New Britain.

14565. Stated to be peddled by Mrs. August Albert. Specific gravity at 60° F., 21.2; total solids, 7.59%; fat, 2.00%. Watered milk.

Milk Sampled by Consumers and Dealers.—During the year 218 samples have been examined for private parties. As the station can in no case vouch for the accuracy of the sampling and as most of the results are not of public interest, details are not here given.

TABLE II.—MILK BOUGHT OF MILKMEN.

Station No.	Sampled.	Dealer.	Specific gravity at 60° F.	Total solids.	Solids not fat.	Fat.	Preservative.	Color.
<i>Bridgeport.</i>								
13727	July 17	Benjamin Barski*	30.0	11.84	8.44	3.4	None	Natural.
14654	31	F. Campbell, Long Hill	27.9	10.89	7.59	3.3	"	"
13728	17	P. E. Card, Farm Dairy	29.6	11.98	8.08	3.9	"	"
13717	17	J. Davis, Trumbull*	26.6	10.59	7.29	3.3	"	"
14664	31	J. M. Disbrow*	28.7	12.02	8.12	3.9	"	"
14653	31	W. E. Disbrow, Sport Hill Dairy	31.3	12.29	8.59	3.7	"	"
14663	31	Ernest Feaz	30.5	12.51	8.41	4.1	"	"
13729	17	John Flynn	28.6	11.27	7.87	3.4	"	"
13725	17	D. M. Fuller, Long Hill	29.7	12.04	8.34	3.7	"	"
13716	17	A. W. Hall*	28.0	10.76	7.36	3.4	"	"
13715	17	Hillside Farm Dairy	31.2	12.52	8.62	3.9	"	"
14666	31	A. C. Howard & Son	32.7	13.31	9.01	4.3	"	"
14670	31	D. B. Hoyt	25.5	10.45	7.15	3.3	"	"
14656	31	Joshua Kent, Sport Hill	30.0	12.50	8.40	4.1	"	"
13721	17	J. E. Macdonald & Son, Maplewood Dairy, Shelton	27.5	10.65	7.45	3.2	"	"
13720	17	J. E. Macdonald & Son, Maplewood Dairy, Shelton	30.9	12.15	8.35	3.8	"	"
13724	17	G. Machalowski, Trumbull	28.9	11.77	8.07	3.7	"	"
13726	17	Wm. McClellan	27.3	11.53	7.83	3.7	"	"
14668	31	F. A. Marsh, Excelsior Dairy, Easton	30.9	13.32	8.72	4.6	"	"
14662	31	Robert Marsh*	30.6	12.80	8.60	4.2	"	"
14660	31	C. G. Miller, Stratfield Dairy*	33.1	13.61	9.31	4.3	"	"
13730	17	Mitchell Dairy	30.6	13.72	8.82	4.9	"	"
13719	17	Geo. Nichols*	27.0	11.22	7.62	3.6	"	"
14659	31	The Nickel Plate Dairy, Long Hill	32.0	13.30	8.90	4.4	"	"
14657	31	Park City Dairy	33.0	13.13	9.13	4.0	"	"
13723	17	H. W. Parks*	28.3	10.95	7.45	3.5	"	"
13718	17	Geo. Randall*	31.2	12.39	8.39	4.0	"	"
14665	31	Howard Randall*	30.6	12.17	8.47	3.7	"	"
14658	31	The Roger Farm Dairy	29.7	11.98	8.18	3.8	"	"
14669	31	W. A. Russell*	30.7	12.42	8.52	3.9	"	"
13722	17	John G. Schmitt, R. F. D. 52*	28.9	11.67	7.97	3.7	"	"
14667	31	Chas. Sherwood, Woodshire Dairy	29.7	13.41	8.51	4.9	"	"
14655	31	J. W. Sherwood	29.9	12.25	8.25	4.0	"	"
14652	31	Howard Silliman*	31.9	12.81	8.61	4.2	"	"
14661	31	Geo. Smith, Long Hill*	31.6	12.82	8.62	4.2	"	"
13731	17	Wm. A. Tatters*	31.1	12.84	8.84	4.0	"	"
<i>Derby.</i>								
14675	Aug. 1	A. B. Barnes, Orange*	30.8	12.78	8.48	4.3	"	"
14680	1	W. B. Booth*	26.3	12.72	7.72	5.0	"	"
14671	1	D. H. Clark	30.9	11.58	8.28	3.3	"	"
14676	1	C. D. Dimon*	31.5	12.67	8.67	4.0	"	"
14673	1	M. W. Johnson, Monroe	31.3	12.67	8.77	3.9	"	"
14678	1	McConnery Bros.*	29.7	11.86	8.16	3.7	"	"
14681	1	G. Muscarello*	30.7	12.93	8.63	4.3	"	"
14674	1	C. W. Ran, Monroe*	30.2	13.68	8.58	5.1	"	"
14672	1	W. W. Saunders*	31.9	13.21	8.81	4.4	"	"
14677	1	F. Wheeler*	29.2	11.98	8.08	3.9	"	"
14679	1	G. Winkler*	30.8	11.29	8.39	2.9	"	"
<i>Glastonbury.</i>								
14714	Aug. 29	A. L. Peck, Maple Crest Dairy	30.5	14.30	9.10	5.2	"	"
14713	29	Frank Urbansky	32.0	12.69	8.79	3.9	"	"

* Statement of driver. Names not marked with * were given on the cart.

TABLE II.—MILK BOUGHT OF MILKMEN—*Continued.*

Station No.	Sampled.	Dealer.	Specific gravity at 60° F.	Total solids.	Solids not fat.	Fat.	Preservative.	Color.
<i>Hartford.</i>								
14692	Aug. 2	J. F. Auglum	29.0	11.61	8.01	3.6	None	Natural.
14693		W. A. Ayer	31.4	12.76	8.56	4.2	"	"
13711	July 14	Brault Bros.	31.1	13.26	8.76	4.5	"	"
13706	Aug. 14	C. J. Christensen, Bloomfield ..	30.3	12.74	8.64	4.1	"	"
14698	Aug. 2	A. Cohen	28.3	11.88	7.98	3.9	"	"
13708	July 14	O. A. Davis, Wethersfield ..	30.0	12.32	8.32	4.0	"	"
14696	Aug. 2	Geo. L. Derby, West Hartford ..	31.4	12.72	8.82	3.9	"	"
14699		H. I. Epstein	30.4	12.93	8.43	4.5	"	"
13713	July 14	J. J. Felth, West Hartford ..	30.2	12.39	8.39	4.0	"	"
13705	Aug. 14	Wm. P. Francis, Bloomfield ..	31.0	12.99	8.59	4.4	"	"
14689	Aug. 2	P. Gulmartin, Bloomfield ..	30.4	12.92	8.72	4.2	"	"
13707	July 14	The Hartford Dairy Co.	30.1	12.08	8.38	3.7	"	"
13703	Aug. 14	The Hartford Dairy Co.	30.4	11.80	8.30	3.5	"	"
14683	Aug. 2	The Hartford Dairy Co.	30.4	12.08	8.38	3.7	"	"
14685		J. A. Jensen	32.4	13.46	8.96	4.5	"	"
13712	July 14	F. Kudkowski, West Hartford ..	29.6	13.28	8.48	4.8	"	"
13704	Aug. 14	J. W. Merrill	26.6	11.95	7.45	4.5	"	"
14690	Aug. 2	F. Orleander, West Hartford ..	27.5	11.00	7.50	3.5	"	"
13714	July 14	Ridgeside Farm, Newington ..	30.2	12.33	8.33	4.0	"	"
13709	Aug. 14	J. C. Saunders, Wethersfield ..	30.3	11.77	8.07	3.7	"	"
14687	Aug. 2	L. W. Seymour	30.6	12.42	8.42	4.0	"	"
14688		Frank Staton, Wethersfield* ..	29.4	12.69	8.19	4.5	"	"
14695		J. O. Stratton	29.3	12.63	8.33	4.3	"	"
14686		Otto Thompson	30.5	13.09	8.39	4.7	"	"
14697		A. B. Waterman, Newington ..	29.7	12.16	8.16	4.0	"	"
13710	July 14	Geo. L. Wells, Wethersfield ..	28.4	10.89	7.59	3.3	"	"
14694	Aug. 2	E. J. Wickham, Manchester ..	28.0	11.83	7.73	4.1	"	"
14691		J. Velmstrom	31.4	12.12	8.62	3.5	"	"
14684		No. 68	31.4	12.78	8.58	4.2	"	"
<i>Middletown.</i>								
14600	July 25	F. B. Ashton*	30.8	13.36	8.66	4.7	"	"
14606		T. Coleman	31.1	13.06	8.56	4.5	"	"
14592	Aug. 25	Daniels Bros., Millbrook Farm ..	30.3	11.72	8.22	3.5	"	"
14601		Chas. T. Davis	33.7	14.40	9.30	5.1	"	"
14602		R. Davis, Oak Grove Dairy ..	31.1	14.29	8.39	5.9	"	"
14609		Jas. Dripps	30.3	13.92	8.82	5.1	"	"
14605		A. W. Gilbert	30.2	12.65	8.45	4.2	"	"
14608		Robert Hubbard	31.6	12.74	8.74	4.0	"	"
14598		F. O. Jackson, Walnut Grove Dairy ..	31.0	11.62	8.42	3.2	"	"
14596		Johnson Bros.	29.9	11.92	8.22	3.7	"	"
14604		Frank Jones*	29.3	12.01	7.91	4.1	"	"
14607		Lee Bros.*	31.3	13.61	8.81	4.8	"	"
14599		H. E. Merrill, Utopia Farm Cromwell ..	30.5	12.44	8.64	3.8	"	"
14603		C. C. Plum	30.4	12.07	8.37	3.7	"	"
14594		E. H. Plum	31.6	13.72	8.82	4.9	"	"
14597		E. J. Roberts, Mapleshade Dairy ..	31.4	12.35	8.65	3.7	"	"
14591		M. R. Rohan, Mt. Higby Farm ..	30.6	12.79	8.49	4.3	"	"
14593		L. M. Tucker, Cedar Hill Dairy ..	31.5	12.17	8.57	3.6	"	"
14595		Fred Zens	31.4	12.87	8.77	4.1	"	"

* Statement of driver. Names not marked with * were given on the cart.

TABLE II.—MILK BOUGHT OF MILKMEN—*Continued.*

Station No.	Sampled.	Dealer.	Specific gravity at 60° F.	Total solids.	Solids not fat.	Fat.	Preservative.	Color.
<i>New Britain.</i>								
13763	July 20	Chas. Bahadoorigian, Stanley Quarter*	24.7	10.50	6.90	3.6	None	Natural.
13760	20	E. A. Elliott, No. 16	31.5	12.67	8.57	4.1	"	"
13772	20	F. J. Elton, No. 7	30.8	12.36	8.36	4.0	"	"
13771	20	A. W. Hall, No. 95	31.3	12.50	8.70	3.8	"	"
13766	20	A. Hansen, No. 78, Kensington*	30.3	12.35	8.55	3.8	"	"
13770	20	C. F. Johnson, No. 34, Kensington	30.5	11.61	8.21	3.4	"	"
13764	20	Edward Lundell, No. 41	31.5	13.82	9.02	4.8	"	"
13768	20	I. J. Newton, West Hartford	31.1	12.93	8.63	4.3	"	"
13761	20	Joe Shapiro, No. 8	28.4	10.92	7.42	3.5	"	"
13773	20	Antoni Switai, No. 29	30.8	12.55	8.75	3.8	"	"
13767	20	Geo. Van Epps, No. 101, Cloverdale Dairy	30.4	14.00	8.70	5.3	"	"
13769	20	J. H. Weymouth, Newington*	30.3	12.35	8.15	4.2	"	"
13765	20	No. 20	30.5	11.92	8.22	3.7	"	"
<i>New Haven.</i>								
14582	July 24	G. G. Allen, Quinnipiac ave.	28.2	11.59	8.09	3.5	"	"
13781	21	W. M. Andrew, Orange	30.4	12.05	8.55	3.5	"	"
14590	24	A. D. Andrus, No. 117	27.5	11.33	7.43	3.9	"	"
14586	24	John J. Augur, No. 10	29.7	11.75	8.25	3.5	"	"
14576	24	W. M. Bailey*	30.9	12.06	8.46	3.6	"	"
13775	21	J. E. Bishop & Sons, No. 2	30.8	12.15	8.55	3.6	"	"
14585	24	Geo. J. Borst, No. 46	29.9	11.46	8.16	3.3	"	"
14577	24	Wm. Brennan, Foxon	29.1	12.03	8.23	3.8	"	"
14568	21	C. W. Brock, Whitneyville	30.8	11.66	8.46	3.2	"	"
13776	21	C. Carlson & Pierson Co.	26.9	10.76	7.46	3.3	"	"
13780	21	Clover Dairy Creamery	27.1	10.84	7.54	3.3	"	"
13774	21	Clover Dairy Creamery	29.9	11.93	8.33	3.6	"	"
13777	21	D. Dwyer, No. 31	29.9	12.46	8.36	4.1	"	"
14571	21	H. J. Fabrique, 195 Lenox st.	29.8	11.69	8.09	3.6	"	"
13785	21	H. J. Fabrique	29.0	11.62	7.82	3.8	"	"
13778	21	J. Gold, No. 8	28.5	11.68	8.08	3.6	"	"
14682	Aug. 1	A. Golden, Scranton & Day sts.	29.9	11.74	8.14	3.6	"	"
14567	July 21	G. B. Hall, No. 137	29.8	12.50	8.50	4.0	"	"
14572	24	J. R. Huston, No. 28	31.0	12.64	8.54	4.1	"	"
14587	24	J. W. Johnson, Pond Lily Dairy	30.3	12.36	8.56	3.8	"	"
13783	21	David Krall, No. 30, 28 Dow st.*	27.4	10.97	7.57	3.4	Formaldehyde	"
14588	24	David Krall, No. 30, 28 Dow st.*	31.4	12.77	8.97	3.8	None	"
14570	21	W. H. Lee, Fairlea Farm	30.3	13.86	8.56	5.3	"	"
14575	24	H. G. Meserole, No. 96, East Haven	31.9	11.72	8.42	3.3	"	"
14579	24	New England Dairy	28.8	12.56	8.36	4.2	"	"
13779	21	R. N. Noble, 1500 Quinnipiac ave.	30.3	11.94	8.34	3.6	"	"
14584	24	L. C. Palmer	29.6	11.38	8.38	3.0	"	"
14574	24	L. C. Palmer, No. 45	30.3	12.66	8.46	4.2	"	"
14583	24	A. Rice, Montowese	25.1	10.37	6.97	3.4	"	"
13782	21	C. W. Russell, No. 141 Tyler City	30.2	12.47	8.37	4.1	"	"
14580	24	R. A. Scholz, No. 113	27.5	15.29	8.19	7.1	"	"
14569	21	J. H. Story, Cedar Hill Dairy	29.4	10.92	8.12	2.8	"	"
14578	24	W. F. Thompson, No. 86	30.5	11.94	8.34	3.6	"	"
13784	21	Max Walley, Washington ave.*	30.6	12.42	8.72	3.7	"	"
14573	24	Spring Glen Farm, James I. Webb, Manager	30.3	11.90	8.10	3.8	"	"

* Statement of driver. Names not marked with * were given on the cart.

TABLE II.—MILK BOUGHT OF MILKMEN—*Continued.*

Station No.	Sampled.	Dealer.	Specific gravity at 60° F.	Total solids.	Solids not fat.	Fat.	Preservative.	Color.
<i>New London.</i>								
14621	July 27	J. Ackerman*	31.9	13.81	8.91	4.9	None	Natural
14631	27	Frank Alexander*	26.1	10.86	7.16	3.7		"
14638	27	L. H. Beckwith, Stony Brook Dairy	30.3	12.57	8.37	4.2	"	"
14637	27	W. H. Benham, Riverside Dairy	28.7	12.49	8.19	4.3	"	"
14625	27	Woodbury Bush*	31.4	12.60	9.00	4.6	"	"
14635	27	C. W. Campbell	31.4	12.97	8.87	4.1	"	"
14626	27	John Carlton, Millstone Farm*	31.1	12.00	8.70	3.3	"	"
14634	27	H. G. Champion, Waterford	31.6	14.36	9.06	5.3	"	"
14629	27	David Coffey*	30.4	13.52	8.72	4.8	"	"
14633	27	F. L. Dimock*	30.5	11.91	8.31	3.6	"	"
14624	27	T. H. Hanney, Waterford	29.8	13.26	8.56	4.7	"	"
14627	27	H. C. Lamphere	30.5	13.00	8.80	4.2	"	"
14628	27	Newbury's Dairy	30.6	14.06	8.86	5.2	"	"
14620	27	Oakland Farm	27.9	11.29	7.69	3.6	"	"
14636	27	Leon St. Germain, Cohanzie st.	30.6	13.10	8.60	4.5	"	"
14630	27	Frank Seilvier*	27.1	12.14	7.54	4.6	"	"
14622	27	G. Snelitzkie*	29.7	13.95	8.75	5.2	"	"
14632	27	H. T. Squire, Ocean ave.	31.1	13.49	8.69	4.8	"	"
14623	27	Julius Watrous*	31.2	12.93	8.83	4.1	"	"
<i>Norwalk.</i>								
13740	July 18	Mrs. E. R. Aiken, Silver Mine Dairy	30.4	14.35	8.75	5.6	"	"
13741	18	David Jenks*	26.5	10.37	7.07	3.3	"	"
13739	18	R. Loudon, Sear Hill Dairy	30.8	13.00	8.50	4.5	"	"
13742	18	C. Ruscoe, No. 10, Maple Grove Dairy	31.4	12.70	8.70	4.0	"	"
13743	18	G. J. Shaller, Comstock Hill Dairy	31.5	13.47	8.57	4.9	"	"
<i>Norwich.</i>								
14643	July 28	H. Burnham*	27.4	11.46	7.96	3.5	"	"
14644	28	J. H. Butler, Norwich Town*	31.3	15.54	9.34	6.2	"	"
14648	28	H. F. Davis*	29.0	12.36	8.16	4.2	"	"
14645	28	W. S. DeWolf*	31.9	13.47	9.17	4.3	"	"
14640	28	G. A. Jenks, Preston*	31.2	12.33	8.53	3.8	"	"
14650	28	H. L. Kenney*	30.3	12.60	8.50	4.1	"	"
14646	28	F. K. Kingsley*	29.9	12.43	8.33	4.1	"	"
14641	28	Fred Palmer*	27.3	13.51	8.11	5.4	"	"
14642	28	John Peckham*	26.6	11.62	7.42	4.2	"	"
14639	28	G. T. Rogers*	31.3	11.41	8.51	2.9	"	"
14647	28	John Rogers*	30.3	13.17	8.67	4.5	"	"
14649	28	Ransom Sholes*	25.9	11.23	7.23	4.0	"	"
14651	28	Lewis Smith*	30.0	13.80	8.50	5.3	"	"
<i>South Glastonbury.</i>								
14715	Aug. 29	James Reed*	28.8	12.48	8.48	4.0	"	"
<i>South Norwalk.</i>								
13745	July 18	G. W. Guyer, Compo Dairy	29.8	11.74	8.14	3.6	"	"
13732	18	Chas. H. Hawxhurst	25.4	10.59	7.09	3.5	"	"
13733	18	Chas. H. Hawxhurst, No. 9	30.4	12.23	8.43	3.8	"	"
13735	18	Chas. E. Hoyt	27.6	11.46	7.76	3.7	"	"
13734	18	W. D. Keeler, Ridgewood Farm	27.3	13.16	7.76	5.4	"	"
13744	18	F. R. Waters, White Oak Dairy	31.5	12.51	8.81	3.7	"	"
13736	18	Webb & Jackson, Model Milk Dairy	31.8	12.71	8.91	3.8	"	"

* Statement of driver. Names not marked with * were given on the cart.

TABLE II.—MILK BOUGHT OF MILKMEN—*Concluded.*

Station No.	Sampled.	Dealer.	Specific gravity at 60° F.	Total solids.	Solids not fat.	Fat.	Preservative.	Color.
		<i>Stamford.</i>		%	%	%		
13696	July 13	J. H. Bedell, No. 109, Long Ridge Dairy	29.0	11.93	8.03	3.9	None	Natural.
13687	13	J. H. Bedell, No. 110, Long Ridge Dairy	28.2	11.74	7.84	3.9	"	"
13688	13	J. H. Bedell, No. 111, Long Ridge Dairy	27.3	10.41	7.51	2.9	"	"
13702	13	Bouton's, No. 119	28.2	13.54	7.94	5.6	"	"
13689	13	L. Burriesce, No. 125, Talmadge Hill	23.2	8.26	6.16	2.1	"	"
13692	13	G. C. Chard, No. 114, Riverbank Dairy	30.6	12.56	8.36	4.2	"	"
13698	13	Consolidated Milk and Cream Co.	31.0	12.50	8.60	3.9	"	"
13701	13	H. I. Dann, No. 133, Mt. Pleasant Dairy	30.8	12.59	8.49	4.1	"	"
13697	13	H. I. Dann, No. 134, Mt. Pleasant Dairy	30.9	12.77	8.57	4.2	"	"
13699	13	Noroton Dairy, No. 118	31.5	12.70	8.80	3.9	"	"
13695	13	Rock Hill Dairy, No. 105	31.5	13.38	8.98	4.4	"	"
13694	13	Darius Sarr, No. 145, Hillcrest Dairy	30.3	12.73	8.43	4.3	"	"
13693	13	Stanley Thompkins, No. 122*	30.3	12.58	8.48	4.1	"	"
13690	13	W. F. Waterbury, No. 103, Maplehurst Dairy	31.7	13.03	8.83	4.2	"	"
13700	13	Emmet L. Weed, No. 116, Springdale Dairy	28.8	10.87	7.77	3.1	"	"
13691	13	Westover Dairy, No. 113, H. L. Palmer, Supt.	30.9	11.89	8.59	3.3	"	"
		<i>Waterbury.</i>						
13752	July 19	James Bergen*	29.8	12.33	8.23	4.1	"	"
13758	19	Cashman Bros., Watertown	30.1	12.28	8.58	3.7	"	"
13747	19	F. P. Clough, Meadow Farm	30.4	12.05	8.35	3.7	"	"
13746	19	T. B. Eggleston, Bucks Hill Road	26.7	10.62	7.42	3.2	"	"
13756	19	I. K. J.	30.8	11.68	8.28	3.4	"	"
13755	19	J. W. Laughlin, Watertown	28.9	12.01	7.81	4.2	"	"
13757	19	Maple Hill Dairy, No. 22	29.0	11.90	7.90	4.0	"	"
13753	19	W. Messick, No. 62	29.2	11.13	7.93	3.2	"	"
13751	19	W. J. Munson, Watertown Road	30.5	12.51	8.51	4.0	"	"
13750	19	Jos. Nagle*	27.8	10.51	7.51	3.0	"	"
13748	19	F. C. Porter*	27.8	10.42	7.42	3.0	"	"
13754	19	G. S. Van Atta, No. 23	27.1	10.23	7.23	3.0	"	"
		<i>Willimantic.</i>						
14610	July 26	Brindamour Bros.	31.9	13.07	8.77	4.3	"	"
14611	26	C. A. Hawkins, Cloverdale Dairy	30.8	11.79	8.19	3.6	"	"
14614	26	C. H. Hoxie	28.0	13.00	8.10	4.9	"	"
14613	26	G. A. Jacobs	30.8	13.57	8.77	4.8	"	"
14612	26	G. W. Rappelye, Phelps Crossing	29.8	12.83	8.33	4.5	"	"
14615	26	F. Rosebrooks	30.0	13.38	8.68	4.7	"	"
14616	26	I. H. Stanton*	30.0	13.29	8.69	4.6	"	"
14617	26	J. H. Stearns, Mountain Milk Farm	31.3	12.50	8.60	3.9	"	"
14619	26	V. D. Stearns, Evergreen Dairy	31.1	12.02	8.82	4.1	"	"
14618	26	Chas. Young*	31.5	15.50	9.40	6.1	"	"

* Statement of driver. Names not marked with * were given on the cart.

CONDENSED MILK.

A sample of condensed milk, sold in bulk (No. 13839), was analyzed at the request of the New England Dairy Co., New Haven, with the following results:

	In the original sample.	In the milk solids.
	%	%
Ash	1.75	5.91
Protein	7.96	26.89
Milk sugar	15.04	50.79
Fat	4.86	16.41
Milk solids	29.61	100.00
Cane sugar	42.75	
Water	27.64	
100.00		

The low percentage of fat in the milk solids shows that the product was made from skimmed milk. According to the United States standards, the milk solids of sweetened condensed milk should contain not less than 25 per cent. of fat, whereas the sample in question contained but 16.41 per cent.

CREAM.

Two samples collected by the Dairy Commissioner, one by L. C. Root, milk inspector, Stamford, and twenty-two by consumers and dealers have been examined. The amount of fat in them ranged from 13.0 to 49.89 per cent. One of the samples sent by a retail dealer contained boric acid.

STERILINE.

This product, analyzed at the request of the Dairy Commissioner, appears to be condensed separator skim milk to which gelatin has been added. The results of the analysis follow:

	%
Casein, albumen and gelatin ($N \times 6.37$)	8.92
Ash	2.16
Fat	trace
Sugar by difference	14.17
Total solids	25.25

EVAPORATED CREAM.

This product, although known commercially as evaporated cream, is (as is usually stated on the label) unsweetened condensed milk.

Two samples sent by Henry D. Lewis, New Haven, have been examined:

13426. Top Notch Evaporated Cream, Van Camp Condensed Milk Co., Effingham, Ill. Contains 28.63 per cent. of total solids and 7.10 per cent. of fat. Not found adulterated.

13427. Borden's Peerless Evaporated Cream, Borden's Condensed Milk Co., New York. Contains 29.03 per cent. of total solids and 7.55 per cent. of fat. Not found adulterated.

The words "Evaporated Cream," *without explanation*, on the label are misleading, and such goods are misbranded within the meaning of the state law.

LARD.

Lard according to the United States standards "is the rendered fresh fat from slaughtered, healthy hogs, is free from rancidity, and contains not more than one per cent. of substances, other than fatty acids, not fat, necessarily incorporated therewith in the process of rendering." Compound lard is a mixture of cotton seed oil with enough stearin to give it the requisite degree of solidity and a small amount of real lard. Lard stearin (the residue left after expressing lard oil), cotton seed stearin (obtained in the manufacture of "Winter" cotton seed oil), or, rarely, paraffine, may be used in place of beef stearin.

Although compound lard is made according to different formulas to meet the requirements of different markets, the product almost invariably contains more cotton seed oil than all the other ingredients taken together. Real lard is a minor constituent.

During the year, seventy-one samples, bought for lard by the station agent from grocers and butchers, have been examined. Of these twenty-four were compound lard and therefore were classed as adulterated (Table III). Of twenty-two samples, later submitted by the Dairy Commissioner, four were pure lard, six were compound lard sold for pure lard and twelve were marked "compound."

TABLE III.—ADULTERATED LARD.

Station No.	Brand.	Dealer.	Price per pound, cents.
13487	Sold in bulk..	<i>Bridgeport.</i> Centennial Tea Co., 1688 Main st.	10
13531	" " "	<i>Danbury.</i> City Grocery, 147 Main st.	8
13649	" " "	<i>Derby.</i> The New York Grocery Co., 217 Main st.	6
13585	" " "	<i>Hartford.</i> Citizen's Grocery & Provision Co., 267 Main st.	10
13621	" " "	<i>Meriden.</i> M. W. Booth, 41 E. Main st.	10
13622	" " "	Meriden Tea & Coffee Co., 77 E. Main st.	10
13558	" " "	<i>Middletown.</i> York State Butter Store, O. H. Cone, 262 Main st.	10
13555	" " "	Middletown Cash Grocery, 354 Main st.	10
13559	" " "	Middletown Cash Grocery, 354 Main st.	11
13641	" " "	<i>Naugatuck.</i> The Union Supply Co., Main st.	13
13561	" " "	<i>New Britain.</i> Public Market, 371 Main st.	8
13599	" " "	<i>New Haven.</i> New Haven Provision Store, 384 Grand ave.	10
13603	" " "	Union Supply Co., 442 State st.	13
13525	" " "	<i>Norwalk.</i> New York Grocery Co., 35-37 Main st.	9
13517	" " "	<i>South Norwalk.</i> Lorenzo Dibble, 13 N. Washington ave.	10
13519	" " "	New York Grocery Co., 118 E. Washington ave.	9
13521	" " "	United Grocery Co., 22 N. Washington ave.	10
13506	" " "	<i>Stamford.</i> O. S. Brown, 54 Park Row	10
13511	" " "	Empire State Tea Co., 303 Main st.	10
13620	" " "	<i>Wallingford.</i> Laden Bros., 104 Center st.	10
13541	" " "	<i>Waterbury.</i> Boston Butter House, 147 S. Main st.	10
13539	" " "	McCarthy's, 671 Broadway and E. Main st.	10
13542	" " "	Public Market, 161-163 S. Main st.	10
13549	" " "	John Tato, 366 W. Main st.	10

OLIVE OIL.

Of the sixty-two samples examined, thirty-two were purchased of grocers and thirty of druggists.

Although all the samples were bought for olive oil, thirteen sold by grocers were marked "Salad Oil," "Nut Oil," etc., and therefore are technically "compounds" and are separately tabulated. (Table V.) In all cases these salad oils were wholly or in large part cotton seed oil.

All the samples found to be adulterated, nine in number, were purchased of druggists in ordinary medicine vials and were distinctly labelled olive oil (Table IV). The adulteration in eight of the samples was cotton seed oil, and in one sample, sesame oil.

A summary of the samples examined follows:

	From Grocers.	From Druggists.	Total.
Not found adulterated.....	19	21	40
Adulterated	0	9	9
Marked "Salad Oil," "Nut Oil," etc.	13	0	13
	32	30	62

TABLE IV.—ADULTERATED OLIVE OIL.

Station No.	Dealer.	Dealer.	Price per bottle, cents.	Ounces of oil in bottle.
	<i>Adulterated with Cotton Seed Oil.</i>			
12648	Sold in druggist's vial.	<i>Bridgeport</i> : Hartigan's Pharmacy, 1299 Main st.	15	4
12646	" " "	Washington Park Pharmacy, E. Main st. and Barnum ave. .	20	4
12672	" " "	<i>Hartford</i> : L. G. Harris, Park and Wadsworth sts.	20	4
12638	" " "	<i>New Haven</i> : Hull's Corner Drug Store, Howard and Congress ave.	15	4
12676	" " "	<i>New London</i> : Taylor's Pharmacy, 239 State st.	15	4
12958	" " "	<i>Torrington</i> : C. H. Dougal, 95 Main street	20	4
12952	" " "	<i>Waterbury</i> : John Moore, 563 E. Main st.	20	4
	<i>Adulterated with Sesame Oil.</i>			
12668	Sold in druggist's vial.	<i>Meriden</i> : F. M. Kibbe & Co., 40 W. Main st.	20	4
12630	" " "	<i>New Haven</i> : S. L. Salisbury, 6 Grand ave.	20	4

TABLE V.—“SALAD OIL,” CONSISTING OF, OR CONTAINING, COTTON SEED OIL.

Station No.	Brand.	Dealer.	Price per bottle, cents.	Ounces of oil in bottle.
12666	G. Campanini, Livorno, Italia. Huile Salad, Medaille D'Or	Meriden: H. E. Bushnell, 75 W. Main st.	25	16
12636	E. Loubon, Nice. Extra Superfine Purest Salad Oil	New Haven: S. S. Adams, 609 Howard ave.	10	6
12632	Midas Frères, Bordeaux. Huile d'Salad	Atlantic & Pacific Tea Co., State st.	10	9
12634	Antonio Fava, Nice. Huile de Salad, d'Aix	C. F. Curtis, 932 State st.	10	5
12631	E. Loubon. Superfine Huile Salad	A. H. Duhan, 1134 State st.	10	6
12635	Union Oil Co., Providence, R. I. Providence Pure Salad Oil	3 G's Cash Store, Edwards and Nash sts.	10	5
12633	E. Loubon, Nice. Huile d'Salad	A. H. Waterbury, 250 Grand ave.	10	6
12656	San Bernadino Salad Oil. H. J. Voss, Agent	Norwalk: N. Y. Grocery Co., 35 Main st.	10	10
12652	M. K. J. & Fils. Huile Supérieure	Stamford: H. Newstad & Co., 35 Pacific st.	10	6
12654	M. Schoenberg & Co., N. Y. White Label Pure California Salad Oil	H. Newstad & Co., 35 Pacific st.	6	3

NUT OIL.

In Europe the oils expressed from the walnut, and other nuts are used as salad oils. The term nut oil is also loosely applied to various other edible oils.

The following three samples labelled “Nuss-Oel,” purchased by the station agent, were found to contain large percentages of cotton seed oil.

No. 12644. Nuss-Oel, bought of G. Englehardt, 599 East Main St., Bridgeport. Contains cotton seed oil.

No. 12641. Excelsior Nuss-Oel, C. W. Walter, Lauterbach a/ Harz, bought of A. Felberg, 222 Congress Ave., New Haven. Contains cotton seed oil.

No. 12650. Blank's Deutsches Importirtes Nuss-Oel, Successor to Licht, 56 Cedar St., Brooklyn, N. Y., bought of Plochin's Delicatessen, 367 Congress Ave., New Haven. Contains cotton seed oil.

CORN OIL.

This oil is expressed from the germs of Indian corn. A sample purporting to be corn oil submitted by S. S. Thompson, New Haven, was found to contain cotton seed oil and, probably, other foreign oils. Refraction at 15.5° C., 72.5; specific gravity at 15.5° C., 0.920; Halphen test, deep red.

COFFEE.

Forty three samples of ground coffee collected by the station have been examined, of which eighteen were adulterated (Table VI), and two were marked "compound." Numerous brands of coffee which during previous years have been found to be pure, were not collected by the agent.

All the adulterated samples, with one exception, were sold in bulk and ten were purchased from branches of the same retail house. Eleven were adulterated with chicory and a material made from wheat middlings resembling ground coffee ("imitation coffee"), two with chicory and peas, one with chicory, peas and a roasted cereal, and four with chicory alone.

The samples marked "compound" were as follows:

12716. "Combination coffee," bought of A. M. Stacy, 123 State St., New London, price 25¢ per pound. Contains chicory and peas.

13473. Sold in bulk. Stamped compound, Standard Tea House, J. H. McGuire, 1019 Main St., Hartford. Contains chicory, peas and cereal.

The following sample of coffee substitute was examined:

11525. Johan Hoff's Malt Coffee, Continental Mfg. & Dis. Co., N. Y., bought of Wm. E. Ford, 511 State St., New Haven. Contained malt and chicory.

Eight samples of coffee were submitted by the Dairy Commissioner, of which one was adulterated and three were marked compound.

Three samples sent by individuals were all found to be pure.

TABLE VI.—ADULTERATED GROUND COFFEE.

Station No.	Brand.	Dealer.	Price per pound, cents.	Adulterants.
		<i>Ansonia.</i>		
12727	Sold in bulk	Walsh Bros., 246 Main st.	25	Chicory, peas.
13645	" " "	Walsh Bros., 246 Main st.	25	" "
		<i>Bridgeport.</i>		
11521	Scheuer's Gold Medal Coffee	S. Scheuer, 52 Cannon st.	30	Chicory.
11519	Sold in bulk	The Village Store Co., 746 E. Main st.	25	Chicory, imitation coffee.*
13462	" " "	The Village Store Co., 746 E. Main st.	25	" " "
11522	" " "	The Village Store Co., 1624 Main st.	25	" " "
13461	" " "	The Village Store Co., 1624 Main st.	25	" " "
11524	" " "	The Village Store Co., 244 State st.	25	" " "
13460	" " "	The Village Store Co., 244 State st.	25	" " "
		<i>Danbury.</i>		
11529	Sold in bulk	The Danbury Grocery Co., Main st.	25	Chicory.
11527	" " "	The Great Atlantic & Pacific Tea Co., 163 Main st.	25	Chicory, imitation coffee.*
13467	" " "	The Great Atlantic & Pacific Tea Co., 163 Main st.	25	" " "
11528	" " "	The Village Store Co., 238 Main st.	25	" " "
13466	" " "	The Village Store Co., 238 Main st.	25	" " "
		<i>Hartford.</i>		
12720	Sold in bulk	Buckley & Reardon, 559 Main st.	25	Chicory, imitation coffee.*
13476	" " "	Buckley & Reardon, 559 Main st.	25	Chicory.
12706	" " "	J. H. McGuire, 1019 Main street	25	Chicory, peas, cereal.
		<i>Waterbury.</i>		
13468	Sold in bulk	J. F. Phelan, 42 E. Main street	25	Chicory.

* Brown lumps made from wheat middlings to resemble coarsely crushed roasted coffee.

SPICES.

Examinations have been made of 159 samples of ground spices, collected by the station, of which 22 were found adulterated or below standard. Particulars with regard to the adulterated samples are given in Table VII; a summary of all the results follows:

Number of samples not found adulterated.	Number of samples adulterated or below standard.	Foreign Matter.
Mustard..... 64	9	Turmeric, wheat product, maize product, rice product.
Black Pepper..... 28	7	Cocoanut shells, maize product, wheat product, olive stones, cayenne, excess of ash.
White Pepper..... 3	1	Maize product.
Cayenne..... 2	1	Maize product, excess of ash.
Cinnamon..... 1	1	Cocoanut shells, excess of ash.
Cloves..... 2	3	Clove stems, excess of ash.
Allspice..... 2	--	
Ginger..... 35	--	

Two of the samples of black pepper contained high percentages of ash indicating either that they were adulterated with pepper shells (the by-product from the preparation of white pepper), or else were contaminated with an undue amount of dirt.

Of ten samples of spices sent by the Dairy Commissioner six were adulterated and two were marked compound.

Five samples were sent by consumers, of which four were pure and one, a sample of black pepper, was grossly adulterated with a wheat product, a maize product, and charcoal.

PREPARED MUSTARD.

This product, also known as German mustard, French mustard, and mustard paste, is prepared from ground mustard seed, or mustard flour (ground mustard seed freed from hulls), salt, spices, and vinegar.

Common admixtures are starchy matter (wheat flour, corn flour, etc.), mustard hulls (a by-product from the manufacture of mustard flour), sugar, chemical preservatives, and artificial colors.

Twenty-eight brands found on sale in Connecticut have been examined. The names of the manufacturers and dealers

TABLE VII.—SPICES, ADULTERATED OR BELOW STANDARD.

Station No.	Brand.	Dealer.	Price per lb., cents.	Ash.	Sand.	Foreign Matter.
12731	<i>Mustard.</i> Sold in bulk	<i>Bridgeport.</i> Partick Lavery, 1219 Pembroke st.	5	2.90	%	Turmeric, wheat product, maize product.
12738	Sold in bulk	E. E. Wheeler, 1131 Main st.	5	4.70	-----	Turmeric, wheat product.
12943	Sold in bulk	<i>Derby.</i> James McEnery, 73 Elizabeth st.	10	4.14	-----	Turmeric, wheat product, rice product.
12852	Sold in bulk	<i>Hartford.</i> N. Y. Butter & Grocery House, 256 Albany ave.	10	3.39	-----	Turmeric, wheat product, rice product.
12768	Samuel S. Beard & Co., New York. Pure Mustard	<i>Meriden.</i> Union Tea Co., 45 W. Main st.	10	5.31	-----	Turmeric, wheat product.
13616	Sold in bulk	<i>New Britain.</i> Winthrop Tea Co., 161 E. Main st.*	10	-----	-----	Turmeric, wheat product.
13565	Samuel S. Beard & Co., New York. Pure Mustard	Winthrop Tea Co., 161 E. Main st.	10	5.05	-----	Turmeric, wheat product.
12838	Sold in bulk	<i>New London.</i> The Boston Tea Store, 231 Bank st.	8	4.31	-----	Turmeric, wheat product, rice product.
12916	Sold in bulk	<i>Waterbury.</i> Santoro Bros., 34 Abbott ave.	10	2.54	-----	Turmeric, wheat product, maize product.
13490	<i>Black Pepper.</i> Sold in bulk	<i>Bridgeport.</i> John Hughes & Co., 1634 Main st.	8	3.03	-----	Cocoonut shells, maize product.
13497	The A. Colburn Co., Philadelphia. Colburn's [A] Spices	H. Isenberg, 109 State st.	10	8.28	-----	Excess of ash.
13647	Sold in bulk	<i>Derby.</i> R. F. Cuddihy, Anson and 6th sts.	8	7.67	-----	Excess of ash.

* Statement.

TABLE VII.—SPICES, ADULTERATED, OR BELOW STANDARD—Continued.

Station No.	Brand.	Dealer.	Price per lb., cents.	Ash.	Sand.	Foreign Matter.
13639	<i>Black Pepper.</i> Sold in bulk.....	<i>Naugatuck.</i> Daly's Grocery Store, 252 Water st.	8	6.60	-----	Cereal product.
13604	Union Supply Co., Jewell Brand Pepper.....	<i>New Haven.</i> Union Supply Co., 442 State st.....	10	4.98	-----	Wheat product.
13619	Sold in bulk.....	<i>Wallingford.</i> Laden Bros., 104 Center st.	10	9.25	-----	Olive stones.
13543	Sold in bulk.....	<i>Waterbury.</i> Manhattan Grocery Co., 171 S. Main street	7	9.05	-----	Olive stones, cayenne.
13607	<i>White Pepper.</i> J. & W. Cahill & Co. Cahill's Pure Aromatic Spices	<i>New Haven.</i> J. & W. Cahill & Co., Church and George sts.....	10	2.35	-----	Maize product.
13608	<i>Cayenne.</i> J. & W. Cahill & Co. Cahill's Pure Aromatic Spices	<i>New Haven.</i> J. & W. Cahill & Co., Church and George sts.....	10	6.30	-----	Maize product.
13627	<i>Cinnamon.</i> Sold in bulk.....	<i>Bristol.</i> W. F. Smithwick, 161 N. Main st....	10	2.18	-----	Cocoanut shells.
13634	<i>Cloves.</i> David Trubee & Co., Bridgeport. Sea Side Mills	<i>Naugatuck.</i> West Side Grocery, 1 Church st. and Rubber ave.	10	8.70	-----	Excess of ash.
13580	Sold in bulk.....	<i>Hartford.</i> The Great Atlantic & Pacific Tea Co., 979 Main st.....	7	9.41	-----	Excess of ash.
13483	Sold in bulk.....	<i>New London.</i> J. M. Miner, 57 Huntington st.	10	9.94	-----	Clove stems, excess of ash.

together with the results of tests for preservatives, colors and cereal starch are given in Table VIII. Statements as to the nature or composition of twelve of the brands taken from the tables are appended as foot notes.

From the table it appears that thirteen brands contained cereal starchy matter, four contained salicylic acid, and twenty-five were colored.

The color of eleven samples was due to turmeric, but as this root is valuable as a spice its use in prepared mustard is legitimate. Coal-tar dyes, belonging either to the nitro-colors or azo-colors ("tropeolins"), were detected in fourteen samples.

Analyses of the samples free from cereal starch are given in Table IX, and of those containing considerable amounts of this admixture, in Table X. The analyses are calculated not only to the material as sold, but also to the dry, fat- and salt-free material. Following the latter figures in Table IX are given the maxima, minima, and average results of Leach's analyses of six samples of ground whole mustard seed.

From Table IX it appears that the percentages of ash, crude fiber, and crude starch in the dry, fat- and salt-free material are usually higher, and of protein lower, than in ground mustard seed, but most of these differences can be explained by the presence of spices, especially those rich in starch, such as turmeric and black pepper. The high per cent. of crude fiber in No. 12699 is quite probably due to an excess of mustard hulls, and the higher per cent. of crude starch may also be due to the action of the acid on these hulls. The presence of added sugar would, of course, raise the per cent. of crude starch.

From these results it appears that the dry, fat- and salt-free material of a mixture of ground mustard seed, salt, vinegar, and spices ought not to contain more than 24 per cent. of crude starch or 12 per cent. of crude fiber, or less than 35 per cent. of protein.

The methods of analysis employed will be described in the Proceedings of the Association of Official Agricultural Chemists for 1905.

CREAM TARTAR.

Only one sample of eighteen examined was found to be adulterated. The description and analysis of this adulterated sample follows:

13591. "Star Brand Pulverized Cream Tartar, Extra Fine. J. S. Brockway & Co., 213 State St., Boston. Warranted quarter pound full weight and guaranteed as to quality and strength." Bought of Joseph Connor & Son, 72 Water St., Norwich. Price 10 cts. per quarter pound package. Adulterated with acid phosphate of lime, alum, plaster, and starch. See page 131.

TABLE VIII.—PREPARED MUSTARD.

Station No.	Brand.	Dealer.	Preservative.	Color.	Starchy Matter.
12688	Joseph Campbell Preserve Co., Camden, N. J.	<i>Bridgeport.</i> Atlantic & Pacific Tea Co., 707 E. Main st.	None	Tropeolin	Maize product.
12687	Campbell's Prepared Mustard* E. A. Charbonneau & Co., Detroit. Belle Isle Brand†	Logan Bros., 1170 Pembroke st.	"	{ Turmeric { Nitro-color	"
12601	The Silver Lane Pickle Factory, F. C. Gould, Silver Lane, East Hartford, Conn.	A. Mertens, 263 State st.	"	{ Turmeric { Nitro-color	Small amount starch.
12689	Chas. Gulden. Moutarde surfinet	N. Y. Grocery, 855 Kossuth st.	"	Turmeric	None.
12690	Eagle Packing Co., N. Y. Dusseldorfer Mustard, Extra Quality§	S. Scheuer, 52 Cannon st.	"	"	Much starch.
12705	Francis H. Leggett & Co., New York. Nabob Prepared Mustard	<i>Bristol.</i> C. A. Lane	"	Turmeric	Small amount starch.
12695	Francis H. Leggett & Co., New York. Premier Prepared Mustard	<i>Danbury.</i> W. D. Baldwin, 93 White st.	"	Nitro-color	None.
12701	Geo. K. McMechen & Son Co., Wheeling, W. Va. McMechen's Wine Flavored Mustard, Reliable Quality||	<i>Hartford.</i> Boston Grocery, 751 Main st.	"	Turmeric	Much starch.
12702	Tice-Marsters Spice Co., Brooklyn. Boston, Extra Quality¶	Cannon & Flannagan, 236 Park st.	"	Tropeolin	Maize product.
12700	The Williams Bros. Co., Detroit. Finest Quality Compound Prepared Mustard**	A. H. Tillinghast, 341 Main st.	"	Turmeric	Wheat and maize.
12698	Janin Frères & Co., Bordeaux. Moutarde diaphane	<i>Meriden.</i> Meriden Tea & Coffee Co., 77 E. Main st.	"	Turmeric	None.
12045	Philip J. Ritter Conserve Co., Philadelphia, Pa. Extra Quality German Mustard. Wein Sent	<i>Middletown.</i> Lawton & Wall, 468 Main st.	"	Turmeric	"

* ** Mustard seed, mustard bran and flour 170, salt 025, spices 005, grain vinegar 800."

† " Pure mustard seed 20%, pure spices and herbs 1½%, salt 2½%, pure grain vinegar 76%." ‡ " Pure and select mustard seed, vinegar and spices."

§ " Vinegar 75, pure mustard 19, pure spices 04½, cereals or, vegetable coloring 00½."

¶ " Compound : mustard seed 20%, spices and herbs 3%, pure malt vinegar 75%, salt 2%."

** " Pure mustard seed 20%, salt 2½%, pure spices and herbs 1½%, pure grain vinegar 76%."

TABLE VIII.—PREPARED MUSTARD—Continued.

Station No.	Brand.	Dealer.	Preservative.	Color.	Starchy Matter.
12699	Chas. Israel & Bros., New York. Friedrichstädter Senf, Extra Quality	<i>New Britain.</i> Union Trading Co., 61 Arch st.	Salicylic acid	Nitro-color	None.
12685	Blenner's German Mustard	<i>New Haven.</i> A. H. Duhan, 1134 State st.	None	Turmeric	Maize product.
12686	H. J. Heinz Co., Pittsburgh. Prepared Mustard.	A. Fehlberg, 222 Congress ave.	"	Natural	None.
12683	Ernst Eulert, Brooklyn, N. Y. Sanssouci Mustard	S. J. Hugo, 120 Crown st.	Salicylic acid	Nitro-color	"
12681	Flaccus Bros., Wheeling, W. Va. Steer's Head*	R. E. Kirt, 1322 State st.		{ Turmeric Nitro color }	"
12682	Kidwell Bros. Co., Baltimore. American Fancy Mustard†	Logan Bros., 341 Grand ave.	None	{ Nitro-color Nitro-color }	"
12680	The John T. Doyle Co., New Haven. Doyle's Country Club Mustard	Union Supply Co., 113 Congress ave.	"	Nitro-color	"
12684	Excelsior Mustard Mills, New York. French Mustard	D. M. Welch & Son, 8 Grand ave.	"	Turmeric	"
12704	The Silver Lane Pickle Factory, F. C. Gould, Silver Lane, East Hartford, Conn.	<i>New London.</i> L. Christensen, 133 Bank st.	Salicylic acid	{ Tropeolin Nitro-color }	Maize product.
12703	LeRoy Packing Co., Boston. LeRoy Extra Quality German Mustard (Wein Senf)	C. H. Thomas, 61 Bank st.	None	Nitro-color	None.
12693	F. D. Lawton & Co., Norwalk†	<i>Norwalk.</i> F. D. Lawton, 47 Main st.	"	Natural	"
12692	Düsseldorf Mustard, Prima Qualität, Etiquette Déposée	N. Y. Grocery Co., 35 Main st.	"	Turmeric	Much starch.
12694	John Robinson & Co., New York. English Club Mustard, Superior Quality§	Raymond & Co., 9 Main st.	"	"	Wheat product.
12697	Alartie & Cie. Moutarde de Bordeaux, Etiquette Déposée	<i>South Norwalk.</i> Gustave Friedrick, Railroad ave.	"	Nitro-color	None.
12696	H. J. Voss, Jersey City, N. J. Voss's XXX German Mustard	N. Y. Grocery, 110 E. Washington street	Salicylic acid	"	Much starch.
12951	Recanier frères, Bordeaux. Moutarde Impériale (tousjours prêt)¶	<i>Waterbury.</i> Kingsbury Branch, 256 N. Main st.	None	{ Tropeolin Nitro-color }	None.

* Mustard seed 18537, spores 02780, malt vinegar 7040a, salt 0122a.

† Compound pure mustard seed 209, salt 252, pure water and vinegar 704.

‡ Liquid mustard compound 209, salt 252, pure water and vinegar 704.

§ Compound mustard compound 209, salt 252, pure water and vinegar 704.

¶ Compound mustard compound 209, salt 252, pure water and vinegar 704.

TABLE IX.—ANALYSES OF PREPARED MUSTARD FREE FROM CEREAL STARCH.

Station No.	In the Material as sold.										In the dry, fat- and salt-free material.					
	Water.	Acidity calcu- lated as acetic acid.	Total solids.	Total ash.	Common salt.	Ash other than salt.	Protein.	Crude fiber.	Crude starch.*	Nitrogen-free extract.	Fat.	Ash.	Protein.	Crude fiber.	Crude starch.*	Nitrogen-free extract.
12689	76.49	3.66	19.85	3.15	1.95	1.20	4.53	0.92	2.35	5.07	6.18	10.24	38.65	7.85	20.05	43.26
12695	79.26	3.22	17.52	3.45	2.53	0.92	4.44	1.09	2.16	4.24	4.30	8.61	41.53	10.20	20.20	39.66
12698	79.72	2.98	17.30	3.10	2.13	0.97	4.22	1.39	2.70	5.09	3.50	8.31	36.16	11.91	23.13	43.62
12945	79.00	3.03	17.97	3.16	2.06	1.10	4.40	1.48	2.02	5.03	3.90	9.16	36.64	12.32	16.82	41.88
12699	79.45	2.80	17.75	4.79	3.69	1.10	3.81	1.68	2.90	5.31	2.16	9.24	32.01	14.12	24.37	44.63
12686	73.01	3.32	23.67	3.09	2.03	1.06	6.12	1.12	2.92	6.11	7.23	7.35	42.47	7.77	20.26	42.41
12683	74.61	3.17	22.22	3.12	1.87	1.25	5.09	1.14	2.60	6.06	6.81	9.23	37.59	8.42	19.20	44.76
12681	83.68	3.00	13.32	2.60	1.78	0.82	3.62	0.77	1.83	4.21	2.12	8.70	38.43	8.17	19.43	44.70
12682	81.36	2.91	15.73	3.32	2.28	1.04	4.16	1.04	2.37	4.76	2.45	9.45	37.82	9.45	21.55	43.28
12680	77.30	2.80	19.90	3.64	2.66	0.98	5.50	1.23	2.44	5.05	4.18	7.68	43.11	9.64	19.13	39.57
12684	79.17	3.18	17.65	3.06	2.13	0.93	4.25	1.14	1.94	5.08	4.12	8.16	37.28	10.00	17.02	44.56
12703	81.66	2.98	15.36	2.80	1.80	1.00	4.56	1.06	2.42	4.47	2.77	9.02	41.12	9.56	21.82	40.30
12693	77.41	2.74	19.85	4.03	2.90	1.13	5.35	1.15	2.48	4.72	4.60	9.15	43.32	9.31	20.08	38.22
12697	77.78	2.90	19.32	3.73	2.58	1.15	5.19	1.16	2.49	5.05	4.19	9.16	41.35	9.24	19.84	40.25
12951	78.90	3.10	18.00	3.79	2.48	1.31	5.40	1.28	2.31	4.30	3.23	10.66	43.94	10.42	18.80	34.98
Maximum	83.68	3.66	23.67	4.79	3.69	1.31	6.12	1.68	2.92	6.11	7.23	10.66	43.94	14.12	24.37	44.76
Minimum	73.01	2.74	13.32	2.60	1.78	0.82	3.62	0.77	1.83	4.21	2.12	7.35	32.01	7.77	16.82	34.98
Average	78.59	3.05	18.36	3.38	2.32	1.06	4.71	1.17	2.40	4.98	4.12	8.94	39.44	9.89	20.11	41.73

Analyses of 6 samples of whole mustard seed by Leach.
(Journ. Amer. Chem. Soc., 1904, 26, 1206.)

	Maximum	Minimum	Average
	7.64	6.28	6.83
	48.31	37.50	44.31
	15.91	11.94	13.82
	48.55	37.84	40.81
	13.82	10.81	12.31

Analyses of 6 samples of whole mustard seed by Leach.
(Journ. Amer. Chem. Soc., 1904, 26, 1206.)

* Reducing matters by direct inversion calculated as starch. Mustard seed contains no real starch.

TABLE X.—ANALYSES OF PREPARED MUSTARD CONTAINING CEREAL STARCH.

Station No.	Water.	In the Material as sold.										In the dry, fat- and salt-free material.				
		Acidity calcu- lated as acetic acid.	Total solids.	Total ash.	Common salt.	Ash other than salt.	Protein.	Crude fiber.	Crude starch.*	Nitrogen-free extract.	Fat.	Ash.	Protein.	Crude fiber.	Crude starch.*	Nitrogen-free extract.
12688.....	80.18	2.65	17.17	2.28	1.60	0.68	3.06	1.04	6.81	9.26	1.53	4.54	21.80	7.41	48.50	65.95
12687.....	79.85	2.72	17.43	2.45	1.51	0.94	4.22	0.94	3.71	6.83	2.99	7.27	32.64	7.27	28.69	52.82
12691.....	85.63	2.78	11.59	2.48	1.66	0.82	2.37	1.20	2.18	4.08	1.46	9.58	27.97	14.17	25.73	48.18
12690.....	84.45	2.72	12.83	2.78	2.08	0.70	3.00	1.00	2.97	5.04	1.01	7.19	30.80	10.27	30.49	51.74
12705.....	83.87	2.60	13.53	2.94	2.21	0.73	3.00	1.59	2.24	3.82	2.18	7.99	32.82	17.40	24.51	41.79
12701.....	87.32	2.79	9.89	2.45	1.97	0.48	1.53	1.32	2.12	3.83	0.76	6.70	21.37	18.44	29.01	53.49
12702.....	79.14	3.42	17.44	2.80	1.89	0.91	3.34	1.03	6.93	8.98	1.29	6.38	23.42	7.22	48.60	62.98
12700.....	78.69	3.54	17.77	2.37	1.55	0.82	4.19	1.20	4.57	7.08	2.93	6.17	31.53	9.03	34.39	53.27
12685.....	81.43	2.91	15.66	2.82	2.08	0.74	3.50	1.04	2.98	5.05	3.25	7.16	33.89	10.08	28.85	48.87
12704.....	81.14	2.86	16.00	4.21	3.39	0.82	3.37	1.26	3.45	5.56	1.60	7.45	30.61	11.44	31.34	50.50
12692.....	84.70	2.80	12.50	2.83	2.20	0.63	2.94	0.96	3.13	4.80	0.97	6.75	31.51	10.29	33.55	51.45
12694.....	70.44	1.86	27.70	3.03	1.87	1.16	6.38	0.22	13.69	15.35	2.72	5.02	27.61	0.95	59.22	66.42
12696.....	79.57	2.39	18.04	3.34	2.60	0.74	4.31	1.16	5.39	8.05	1.18	5.19	30.42	8.13	37.80	56.46
Maximum	85.63	3.54	27.70	4.21	3.39	1.16	6.38	1.59	13.69	15.35	3.25	9.68	33.89	18.44	59.22	66.42
Minimum	70.44	1.86	9.89	2.28	1.51	0.48	1.53	0.22	2.12	3.82	0.76	4.84	21.37	0.45	24.51	41.79

* Reducing matters by direct inversion calculated as starch. Mustard seed contains no real starch.

ANALYSIS.

Sulphuric acid	27.51
Phosphoric acid	8.83
Lime	12.16
Alumina	4.95
Starch and other substances.....	46.55
	100.00

HORSE RADISH.

A sample labelled: "Pure Horse Radish. Guaranteed Strictly Pure. Put up by Richard Zastrow, New Haven, Conn." was found to contain maize starch.

VANILLA EXTRACT.

Standard vanilla extract of the United States Pharmacopœia is prepared from vanilla beans, cane sugar, and dilute alcohol, 100 grams of the beans being used for each 1000 cc. of the extract.

The common adulterants of vanilla extract are tonka bean extract, artificial vanillin, artificial coumarin, carmel, and coal-tar colors. Artificial vanillin is identical with the chief flavoring principle of the vanilla bean, but the extract made from this substance lacks the true flavor of genuine vanilla extract, owing to the absence of other substances, which cannot be successfully imitated. At the present time vanillin, itself an adulterant, is adulterated with acetanilid (antifebrine), which not only is worthless for flavoring but is injurious to health. Tonka beans are much cheaper than vanilla beans and have a ranker flavor due to coumarin, which is also prepared artificially for use in extracts.

Eighty-seven samples of vanilla extract have been examined, of which twenty-five were not found adulterated, forty-seven were variously adulterated, and fifteen were labelled compound.*

The adulterated samples are described in Table XI. Coumarin was present in thirty-nine samples and acetanilid in

* The method employed for the determination of vanillin, coumarin and acetanilid is that described by Winton and Bailey: Journ. Amer. Chem. Soc., 1905, 27, 719; the other methods are those given by Winton and Silverman; Rep. of this Station, 1901, 154; Journ. Amer. Chem. Soc., 1902, 24, 1128

TABLE XI.—ADULTERATED EXTRACT

Station No.	Brand.	Dealer.
12798	Eureka Mfg. Co., Hartford, Conn.	Ansonia : P. W. Forgarty, 13 High street
12799	The Twentieth Century Extract Co., Hartford, Conn.	Peoples Grocery Co., 138 Main st.
12800	Walsh Bros., Ansonia, Conn.	Walsh Bros., 246 Main st.
12612	Sold in druggist's vial.	Bridgeport : Dupee's Pharmacy, 59 Fairfield ave.
12603	Victor Mfg. Co., Hartford, Conn.	E. L. Sullivan, 1142 E. Main st. ..
12606	The Twentieth Century Extract Co., Hartford, Conn.	The Logan Bros. Co., 410 E. Main street
12605	Good Value Extract Co., New York, Good Value	W. L. Woolfram, 1001 E. Main st.
12857	Sold in druggist's vial	Bristol : Merriman Bros., 149 Main street
12781	Baldwin & MacDonald, Danbury, Conn.	Danbury : Baldwin & MacDonald, 256 Main st.
12785	The Union Pacific Tea Co., New York, Sovereign	Union Pacific Tea Co., 253 Main street
12854	Sold in druggist's vial	Hartford : T. J. Blake, Jr., Albany ave., and East st.
12891	Aetna Mfg. Co., Hartford, Conn. ..	Brown, Thompson & Co., Main street
12890	J. T. Robertson, Hartford, Conn., Robertson's	S. B. Cowles, 156 Albany ave.
12803	H. M. Grant, Meriden, Conn., Elite Brand	Meriden : Grant's Tea Store, State and E. Main sts.
12804	Sold in druggist's vial	Geo. Lamping, E. Main st.
12801	Union Tea Co., New Britain & Meriden, Conn., Superior Vanilla Flavoring	Union Tea Co., 45 W. Main st.
12903	D. Johnson & Co., Middletown, Conn.	Middletown : C. Allison, 31 Main street
12900	J. G. Hedges, Middletown, Conn. ..	Lawton & Wall, 468 Main st.
12910	New England Tea Co., Middletown, Conn.	New England Tea Co., 442 Main street
12907	The McKee Medicine Co., Middletown, Conn.	O. Thompson & Co., 592 Main st.
12929	Sold in druggist's vial	Naugatuck : S. Gladding, Jr., & Co., Church st.
12930	Arcadian Extract Co., Union City, Conn.	Moulthrop & Gray, Water st.
12811	Manufacturer not given	New Britain : J. W. Cotter & Co., Elm & Park sts.
12810	C. H. Talcott & Co., Hartford, Conn., Delmonico	Wm. Foulds, 236 Park st.
12814	Sold in druggist's vial	J. H. Lutz, 253 E. Main st.
12806	J. E. Murphy, New Britain, Conn.	J. E. Murphy, 500 Main st.
12599	Sold in druggist's vial	New Haven : J. P. Crowley, 302 Congress ave.
12968	Frederick Bros.	Frederick Bros., 253 Davenport avenue
13442	Sterling Extract Co., New York, Sterling	Gibbons Bros., State & Pearl sts.
12969	The Carlson Tea & Butter Co., New Haven, Standard Quality	The Carlson Tea & Butter Co., 488 State st.

OR ESSENCE OF VANILLA.

Station No.	Price per bottle, cents.	Capacity of bottle, ounces.	Vanillin.	Coumarin.	Acetanilid.	Color.
12798	15	1½	0.14	0.00	%	Artificial.
12799	15	1½	0.27	0.03		Artificial.
12800	20	2½	0.66	0.12		Artificial.
12612	20	4	0.23	0.05		Artificial.
12603	10	1½	0.21	0.04		Artificial.
12606	15	1½	0.23	0.03		Artificial.
12605	10	1½	0.05	0.10		Artificial.
12857	40	4	0.05	0.03		Natural.
12781	15	2	0.59	0.09		Artificial.
12785	20	2	0.63	0.13		Artificial.
12854	35	4	0.60	0.04		Artificial.
12891	9	1½	0.28	0.04		Artificial.
12890	25	2	0.16	0.05		Artificial.
12803	10	1½	0.14	0.08		Artificial.
12804	35	4	0.13	0.04		Natural.
12801	15	1½	0.21	0.04		Artificial.
12903	15	1½	0.21	0.04	0.08	
12900	20	2	0.63	0.07		
12910	20	2	0.15	0.03		
12907	25	4	0.32	0.00	0.13	
12929	40	4	0.24	0.08		Natural.
12930	25	2	0.31	0.09		Artificial.*
12811	30	4	0.71	0.06		Artificial.
12810	25	2	0.12	0.07		Natural.
12814	30	4	0.54	0.05		Artificial.
12806	10	1½	0.35	0.06	0.13	Artificial.
12599	35	4	0.59	0.10		Artificial.
12968	10	1½	0.20	0.03		Artificial.
13442	25	2	0.43	0.00		Artificial.*
12969	12	2	0.26	0.03		Artificial.

* Coal-tar dye.

TABLE XI.—ADULTERATED EXTRACT

Station No.	Brand.	Dealer.
12966	The John T. Doyle Co., New Haven, Doyle's	John L. Thuesen, 309 Oak st.
12589	Tower's	H. M. Tower, 379 Congress ave.
12824	Nichols & Harris, New London, Conn.	New London: Keefe, Davis & Co., 125 Bank st.
12823	Chas. M. Taylor, New London, Lauman's	C. H. Thomas, 61 Bank st.
12870	Slater Extract Co., Pawtucket, R. I.	Norwich: Disco Bros., 267 Main street
12866	Sold in druggist's vial	Putnam: Simon Farley, 54 Elm street
12622	Manufacture not given	Stamford: O. S. Brown, 50 Park Row
12616	Sold in druggist's vial	A. L. Embree, 3 Park Row
12793	Seeman Bros., New York, Warfield Brand	So. Norwalk: C. Becker & Son, 141 E. Washington st.
12787	Sold in druggist's vial	G. C. Stillson, E. Washington st.
12932	Sage's Laboratory, Torrington, Conn., Sage's Choice No. 1	Torrington: Torrington Co-operative Co., 135 Main st.
12911	Premium Brand	Waterbury: N. Y. & China Tea Co., 181 S. Main st.
12927	Sold in druggist's vial	Riverside Pharmacy, Bank and Riverside sts.
12923	" " " "	The McCarthy Pharmacy, 434 S. Main st.
12862	" " " "	Willimantic: Chas. deVillers, 873 Main st.
12937	The C. L. Cotton Perfume & Extract Co., Earlville, N. Y., O.K.	Winsted: King & Gay, Main st. ..
12934	Sold in druggist's vial	Wm. H. Mills, 390 Main st.

four, the latter being undoubtedly an adulterant of the artificial vanillin employed. Caramel or a similar substance was detected in thirty-two samples and a coal-tar dye in two.

All but three of the compound extracts contained coumarin and two of these in addition contained acetanilid. All were artificially colored. Details with regard to these samples, including the formulas printed on the bottles, are given in Table XII.

Acetanilid being injurious to health, the sale of an extract containing it is illegal, even when marked compound.

LEMON EXTRACT.

Pure lemon extract, prepared according to the United States Pharmacopœia, is an alcoholic solution containing five parts by volume of lemon oil, colored with lemon peel.

OR ESSENCE OF VANILLA.

Station No.	Price per bottle, cents.	Capacity of bottle, ounces.	Vanillin.	Coumarin.	Acetanilid.	Color.
			%	%	%	
12966	10	1	0.60	0.10		Artificial.
12589	10	1 ½	0.40	0.07		Artificial.
12824	25	2	0.07	0.00		Artificial.
12623	20	1 ½	0.52	0.10		Artificial.
12870	25	4	0.36	0.10		Artificial.
12866	40	4	2.55	0.09		Artificial.
12622	10	1 ½	0.30	0.05		Artificial.
12616	40	4	0.10	0.05		Artificial.
12793	15	1 ½	0.04	0.00		Artificial.
12787	35	4	0.07	0.04		Natural.
12932	25	2	0.11	0.05		
12911	10	1 ½	0.19	0.00	0.15	
12927	20	4	0.20	0.00		Artificial.
12923	40	4	0.90	0.06		
12862	35	4	0.36	0.00		Artificial.
12937	20	2	0.09	0.06		Artificial.
12934	40	4	0.25	0.03		Artificial.

Since the alcohol in a good extract costs about four times as much as all the other constituents together, unscrupulous manufacturers are accustomed to reduce the expense of manufacture by substituting dilute alcohol.

But lemon oil is practically insoluble in dilute alcohol, hence by reducing the strength of the alcohol the manufacturer cuts out the lemon oil almost entirely, thus rendering the extract almost worthless for flavoring purposes.

A good extract, on dilution with half its bulk of water, should at once become cloudy from the separation of lemon oil which later rises to the surface.

Many of the brands on the market contain so little lemon oil that it can hardly be detected either by chemical analysis or by the nostrils. They are commonly made either by shaking

TABLE XII.—COMPOUND EXTRACT

Station No.	Brand.	Dealer.
12602	Trumbull & Co., Hartford, Conn.*	<i>Bridgeport</i> : Patrick Lavery, 1219
12610	G. W. Smith, Village Store, Bridgeport, Conn. G. W. Smith †	Pembroke st. The Village Store Co., 1624 Main street
12786	Queen City Mfg. Co., Newburgh, N. Y. Queen City †	<i>Danbury</i> : L. Libertino, 51 Liberty street
12893	St. John's §	<i>Hartford</i> : Dow's Grocery, 2 Church street
12894	John H. McGuire, Hartford, Conn. The Waldorf Brand |	J. H. McGuire, 1019 Main st.
12901	Oakdale Packing Co., Phila. Oakdale	<i>Middletown</i> : Middletown Cash Grocery, 354 Main st.
12586	Sold in druggist's vial ¶	<i>New Haven</i> : M. F. Hope, 359 Grand ave.
12600	F. J. Markle, New Haven. Gold Medal Brand	F. J. Markle, 101 Dixwell ave.
12596	Forest City Extract Co., Portland, Maine. Forest City**	E. Schoenberger & Son, 92 George street
12581	The Union Supply Co.'s	Union Supply Co., 113 Congress ave.
12583	Star Extract Co., Boston. Star Brand	D. M. Welch & Son, 8 Grand ave.
12863	Haskill, Adams & Co., Boston ††	<i>Putnam</i> : Edward Mullan, Main st.
12623	Hart's	<i>Stamford</i> : E. O. Lester, 282 Main st.
12617	C. N. Searle, New Haven ††	J. L. Smallhorn, 233 Main st.
12922	Miner, Read & Garrette, New Haven. Anchor Brand	<i>Waterbury</i> : Penn. Merchandise Co., 118 E. Main st.

* "Ext. vanilla beans 7.20%, alcohol 13.50%, sugar 12.60%, caramel, .80%, vanillin .34%, coumarin .06%, water 65. 60%."

† "Formula compound. 45 parts hydro-alcoholic solution Mexican vanilla beans (active principle)."

"45 parts hydro-alcoholic solution tonka beans (active principle)."

"10 parts hydro-saccharated solution, colored artificially with caramel."

‡ "Vanilla 17, vanillin 10, coumarin 8, syrup 100, alcohol dil. 8.40, color 25."

§ "Formula compound. 45 parts hydro-alcoholic solution Mexican vanilla beans (synthetically prepared)."

"45 parts hydro-alcoholic solution tonka beans (active principle)."

"10 parts hydro-saccharated solution with caramel."

¶ "Vanilla 1.00, aqua 4.84, tonka 2.70, sugar 1.44, caramel .02."

† "Statement. Contains coumarin and vanillin."

** "Crystallized sugar 13.72, corn syrup 11.14, caramel .57, Spanish fruit juice 4.57, glycerine chemically pure 1.71, vanillin .03, coumarin .21, pure grain alcohol 7.46, distilled water 60.59."

†† "1-2 vanilla, 1-2 tonka, colored."

†† "Made from vanillin and coumarin."

lemon oil with weak alcohol and removing the excess of oil, or by dissolving a little "citral" or other substitute in dilute alcohol. The bogus extracts are usually colored a beautiful golden-yellow with turmeric tincture or, more commonly, a coal-tar dye. An ounce of such an extract selling for 10 cents contains material costing but a fraction of a cent, and almost worthless as a flavor.

OR ESSENCE OF VANILLA.

Station No.	Price per bottle, cents.	Capacity of bottle, ounces.	Vanillin.	Coumarin.	Acetanilid.	Color.
			%	%	%	
12602	10	1	0.31	0.04		Artificial.
12610	15	2	0.08	0.05		Artificial.
12786	10	1½	0.23	0.07	0.11	Artificial.
12893	10	1½	0.07	0.05		Artificial.
12894	15	1½	0.04	0.07		Artificial.
12901	15	1½	0.14	0.00		Artificial.
12586	40	4	0.38	0.10		Artificial.
12600	10	1½	0.12	0.00		Artificial.
12596	25	1½	0.07	0.12		Artificial.
12581	10	1½	0.04	0.05		Artificial.
12583	10	1½	0.11	0.00		Artificial.
12863	35	4	0.05	0.09		Artificial.
12623	10	1½	0.04	0.09		Artificial.
12617	25	4	0.40	0.11	0.15	Artificial.
12922	10	1½	0.14	0.05		Artificial.

Eighty-seven brands of lemon extract have been examined during the year. Only twenty-five of these contained 4.50 per cent. of lemon oil by weight (equivalent to about 4.30 per cent. by volume) and were therefore of good quality. The remaining sixty-two samples, of which fifteen were marked as compounds, contained in every instance less than 4.50 per cent. of pure lemon oil and in most instances only a trace. One sample (No. 12964), contained a foreign oil of the nature of turpentine. Most of the samples were colored either with turmeric or coal-tar dyes (nitro-colors, azo-colors, etc.).

BUTTER.

During the year the Dairy Commissioner has submitted twenty-five samples, of which ten were renovated butter. Only three of these samples were labelled "renovated."

One sample sent by O. G. Beard, Shelton, and two sent by the Yale Dining Hall were not found adulterated.

A sample sent by The L. C. Bates Co., New Haven, was found to be renovated butter.

TABLE XIII.—EXTRACT OR ESSENCE OF LEMON, ADULTERATED

Station No.	Brand.	Dealer.
12899	Walsh Bros.	Ansonia: Walsh Bros., 246 Main street
12601	The Union Pacific Tea Co., New York, Sovereign	Bridgeport: Union Pacific Tea Co., 604 E. Main st.
12858	Sold in druggist's vial	Bristol: Perry N. Holley, Main st.
12856	The C. L. Cotton Perfume & Extract Co., Earlville, N. Y., Cotton's.	C. A. Lane
12782	Sam'l Stuart & Co., Hartford, Conn. Standard Quality	Danbury: M. McPhelemy, 42 White st.
12896	Sold in druggist's vial	Derby: Kelty's Pharmacy, 42 Elizabeth st.
12898	J. D. Welch & Co., New Haven, Derby & Ansonia, Conn.	D. M. Welch & Son, 312 Main st.
12815	Trumbull & Co., Hartford, Conn.	Hartford: D. F. Burns, 304 Park street
12964	M. C. Monagle & Rogers, Middletown, N. Y.	Hills & Co., 372 Asylum st.
12853	Sold in druggist's vial	N. K. Morgan, 147 Albany ave.
12895	Wise, Smith & Co., Superior	Wise, Smith & Co., Main st.
12905	Bergquist Bros., Concentrated	Middletown: Bergquist Bros., 585 Main st.
12902	D. Johnson & Co., Middletown, Conn.	D. J. Hartman, 528 Main st.
12909	New England Tea Co.	New England Tea Co., 442 Main street
12908	Perfect Extract Co., Hartford, Conn. Perfect	O. Thompson & Co., 592 Main st.
12813	Manufacturer not given	New Britain: J. W. Cotter & Co., Elm & Park sts.
12807	Victor Mfg. Co., Hartford, Conn. ..	Thos. McCabe, 591 Main st.
12808	Union Tea Co., Superior Lemon Flavoring	Union Tea Co., 317 Main st.
12967	The Union	New Haven: Wm. R. Bailey, 413 Congress ave.
12585	Sold in druggist's vial	J. T. Hillhouse, Grand ave. & E. Pearl st.
12595	F. J. Markle, Concentrated	F. J. Markle, 105 Broadway
12970	The Carlson Tea & Butter Co., Standard Quality	The Carlson Tea & Butter Co., 488 State st.
12590	H. M. Tower, Tower's Concentrated ..	H. M. Tower, 379 Congress ave.
12580	Star Extract Co., Boston, Star Brand ..	D. M. Welch & Son, 28 and 30 Congress ave.
12826	Sold in druggist's vial	New London: Taylor's Pharmacy, 239 State st.
12825	Bakers' Extract Co., New York, Bakers' Special.	The Mohican Co., 241 State st.
12871	Slater Extract Co., Pawtucket, R. I. Concentrated	Norwich: Disco Bros., 267 Main street
12971	J. E. Thompson, New York, Thompson's Triple	Welcome Smith, 137 Main st.
12864	The Lee & Osgood Co., Norwich, Conn., Concentrated	Putnam: Edward Mullan, Main st.

OR BELOW STANDARD. (LEMON OIL BELOW 4.50 PER CENT.)

Station No.	Price per bottle, cents.	Capacity of bottle, fluid ounces.	Specific gravity at 15.5° C.	Alcohol by weight.	Lemon oil by weight.		Refractive index of precipitated oil at 90° C.	Color.
					Polariscope method.	Mitchell's precipitation method.		
12899	20	2	.8584	% 73.94	% 2.60	% 2.90	1.4691	Turmeric.
12601	20	2	.9120	50.14	0.63	0.61		Azo-dye.
12858	35	4	.8265	83.22	4.19	4.16		
12856	20	2	.9315	43.95	0.15	0.00		Artificial.
12782	10	1½	.9087	54.20	0.53	0.56		Nitro-color.
12896	25	4	.8400	80.36	3.76	4.30	1.4697	
12898	15	2	.8736	66.95	1.79	1.99	1.4697	
12815	10	1½	.9130	49.95	0.52	0.47		
12964	50	4	.8223	83.65	4.49†	7.52†	1.4672†	
12853	20	4	.8552	73.64	2.60	2.61	1.4697	
12895	13	2	.9238	40.64	0.38	0.74		Nitro-color.
12905	30	4	.8615	74.96	0.44	0.60		
12902	25	2	.9425	37.99	0.00	0.00		Azo-dye.
12909	20	2	.9636	25.96	0.00	0.00		Azo-dye.
12908	15	1½	.9132	51.24	0.41	0.28		Nitro-color.
12813*	20	4	.9772	23.99	0.10	0.00		Nitro-color.
12807	10	1	.9395	39.97	0.14	0.00		Nitro-color.
12808	10	1½	.9405	39.55	0.05	0.00		Nitro-color.
12967	10	1½	.9143	51.61	0.40	0.46		Nitro-color.
12585	20	4	.8792	65.57	1.47	1.47		
12595	10	1½	.9789	13.75	0.12	0.00		Nitro-color.
12970	12	1½	.9133	50.83	0.44	0.56		Artificial.
12590	10	1½	.9143	51.20	0.40	0.47		Artificial.
12580	10	1½	.9737	19.62	0.05	0.00		Nitro-color.
12826	25	4	.8736	66.53	2.49	2.66		
12825	20	4	.8197	87.85	3.27	3.14	1.4691	Azo-dye.
12871	25	4	.9562	30.35	0.31	0.00		
12971	50	4	.8763	66.20	1.52	1.86	1.4694	Azo-dye.
12864	25	4	.8222	86.01	3.04	3.13		

* Contained 8.68 per cent. of non-volatile residue (largely glycerine).

† The disagreement of results on lemon oil by the two methods and the low refraction of the oil are proofs of adulteration.

TABLE XIII.—EXTRACT OR ESSENCE OF LEMON, ADULTERATED

Station No.	Brand.	Dealer.
12794	Hart's	<i>So. Norwalk</i> : F. D. Lawton, 22 Main st.
12792	Chester Mfg. Co., New York, Chester's Extra Fine	N. Y. Grocery Co., 110 E. Washington st.
12789	J. G. Powers & Co., New York, 20th Century	Edwin Wilcox, 70 E. Washington street
12620	Lambert & Lowman, Detroit, Royal Brand	<i>Stamford</i> : H. S. Daskham, 23 Atlantic st.
12625	Fitch A. Hoyt, High Grade	F. A. Hoyt, Atlantic Square.
12619	Sold in druggist's vial	W. H. Jones, 173 Main st.
12921	The John T. Doyle Co., New Haven, Conn., Doyle's	<i>Waterbury</i> : Dixon's Grocery, 332 N. Main st.
12912	Sage's Laboratory, Torrington, Conn., Sage's Choice No. 1 Extract	The White Simons Co., 165 Bank st.
12859	C. H. Talcott & Co., Hartford, Conn., Delmonico	<i>Willimantic</i> : A. A. Trudeau, 941 Main st.
12861	Sold in druggist's vial	Wilson's Drug Store, 723 Main st.

OR BELOW STANDARD. (LEMON OIL BELOW 4.50 PER CENT.)

Station No.	Price per bottle, cents.	Capacity of bottle, fluid ounces.	Specific gravity at 15.5 C.	Alcohol by weight.	Lemon oil by weight.		Refractive index of precipitated oil at 30 C.	Color.
					Polariscope method.	Mitchell's precipitation method.		
12794	10	1½	.9219	48.04	0.44	0.00		Azo-dye.
12792	10	2	.9664	23.12	0.10	0.00		Nitro-color.
12789	10	4	.9140	50.44	0.52	0.37		Nitro-color.
12620	35	4	.9416	38.11	0.11	0.00		Azo-dye.
12625	25	2	.8520	75.53	3.15	3.33	1.4691	
12619	40	4	.8428	79.21	3.28	3.47	1.4697	Turmeric.
12921	25	2	.9390	40.36	0.14	0.00		Artificial.
12912	18	2	.8990	58.45	0.72	0.58		Turmeric.
12859	25	2	.8254	86.84	3.19	2.92	1.4691	Turmeric.
12861	20	4	.8612	71.02	2.21	3.09	1.4697	

TABLE XIV.—“COMPOUND” EXTRACT

Station No.	Brand.	Dealer.
12611	S. Scheuer & Co., Easton, Pa., “Tru-Blu.”	Bridgeport: S. Scheuer, 52 Cannon street
12609	G. W. Smith, Village Store, Bridgeport, Conn. *	The Village Store Co., 244 State street
12830	Forest City Extract Co., Portland, Me., Forest City†	Hartford: Boston Grocery, 751 Main st.
12892	St. Johns*	Davis Grocery, 2 Church st.
12809	The Union Supply Co., Highly Concentrated	New Britain: Union Supply Co., 483 Main st.
12592	Centennial American Tea Co., Concentrated	New Haven: The Centennial Am. Tea Co., 363 State st.
12627	Pansy Extract Co., Phil., Pansy ‡	Norwalk: Grand Central Grocery, 19 Main st.
12874	Leech & Co., New York, “Plymouth”	Norwich: The Mohican Co., Main street
12795	Brunswick Mfg. Co., New York, Brunswick §	So. Norwalk: Central Food Co., Railroad & Washington sts. ...
12791	156 Chambers st., New York, Arcadian	F. F. Sherman, 17 N. Main st.
12913	Public Market, Waterbury, Conn. Gold Seal*	Waterbury: Kingsbury Branch, 256 N. Main st.
12936	The C. L. Cotton Perfume & Extract Co., Earlville, N. Y. O. K. |	Winsted: Larkins & Sparks, 110 Main st.

* “Formula compound: 70 parts hydro-alcoholic solution oil lemon, 30 parts aqua, colored artificially with trace of turmeric.”

† “Oil lemon .13, imported citral .07, redistilled oil lemon grass .07, distilled water 61.66, pure grain alcohol 37.53, coloring matter .54.”

‡ “Alcohol, extract lemon peel, oil lemon, water.”

§ “Prepared from absolutely pure lemon oil dissolved in 100 % pure U. S. pure spirits, without addition of coloring or other substance.”

| “Oil lemon 15, tartrazine non-poisonous color, alcohol dilute 989.”

MOLASSES.

Two hundred samples were submitted by the Dairy Commissioner, of which fifteen contained glucose syrup.

MAPLE SUGAR.

A sample sent by W. H. Olcott, South Manchester, and another sent by John N. Lane, Meriden, were not found adulterated.

JAM.

A sample of jam from The John T. Doyle Co., New Haven, contained a currant product (possibly the residue from the manufacture of currant jelly), glucose, starch, and a coal-tar dye.

OR ESSENCE OF LEMON.

Station No.	Price per bottle, cents.	Capacity of bottle, fluid ounces.	Specific gravity at 15.5° C.	Alcohol by weight.	Lemon oil by weight.		Refractive index of precipitated oil at 30° C.	Color.
					Polariscope method.	Mitchell's precipitation method.		
12611	20	4	.9589	28.73	0.14	0.00		Nitro-color.
12609	15	2	.9329	42.39	0.14	0.00		Azo-dye.
12820	20	1½	.9538	31.91	0.37	0.00		Nitro-color.
12892	10	2	.9573	30.70	0.05	0.00		Turmeric.
12809	15	1½	.9808	13.79	0.10	0.00		Nitro-color.
12592	20	1½	.9858	9.82	0.10	0.00		Nitro-color.
12627	10	1½	.9530	32.87	0.08	0.00		
12874	10	1	.9669	23.69	0.00	0.00		Azo-dye.
12795	10	1	.9365	42.63	0.51	0.00		
12791	10	1½	.9545	31.39	0.10	0.00		Artificial.
12913	15	2	.9604	28.08	0.10	0.00		
12936	10	1½	.9613	27.18	0.00	0.00		Nitro-color.

VINEGAR.

Three samples drawn by the Dairy Commissioner were not found adulterated.

A sample marked cider vinegar sent by the Hallett Table Water Co., Bridgeport, contained but 3.08 per cent. of acid and 1.26 per cent. of solids and was therefore below standard.

CHOCOLATE AND COCOA.

Two samples of chocolate sent by the Howland Dry Goods Co., Bridgeport, contained a small amount of maize starch. A sample of cocoa from the same house was not found adulterated.

WHISKEY.

Three samples submitted by the New Haven Board of Health were tested for wood alcohol with negative results.

TABLE XV.—SUMMARY OF THE RESULTS OF EXAMINATIONS
OF FOOD PRODUCTS IN 1905.

	Not found adul- terated.	Adulterated or below standard.	Com- pounds.	Total number examined.
<i>Sampled by Station.</i>				
Milk	95	133	---	228
Lard	47	24	---	71
Olive Oil and Substitutes	40	9	13	62
Coffee and Coffee Substitutes	23	18	3	44
Vanilla Extract	25	47	15	87
Lemon Extract	35	39	12	86
Spices	137	22	---	159
Prepared Mustard	---	---	28	28
Cream Tartar	17	1	---	18
Total	419	293	71	783
<i>Sampled by Health Officers, Consumers and Dealers.</i>				
Milk	182	36	---	218
Cream	22	1	---	23
"Evaporated Cream"	2	---	---	2
Condensed Milk	---	1	---	1
Butter	3	1	---	4
Vinegar	---	1	---	1
Coffee	2	---	---	2
Coffee Substitute	---	1	---	1
Spices	4	1	---	5
Chocolate	---	2	---	2
Cocoa	1	---	---	1
Rock Candy Drips	1	---	---	1
Maple Syrup	1	---	---	1
Jam	---	1	---	1
Horse Radish	---	1	---	1
Corn Oil	---	1	---	1
Whiskey	3	---	---	3
Olive Oil	2	1	---	3
Vanilla Extract	---	---	1	1
Total	223	48	1	272
<i>Sampled by Dairy Commissioner.</i>				
Cream	5	---	---	5
"Steriline"	---	---	1	1
Butter	15	7	3	25
Vinegar	3	---	---	3
Molasses	185	15	---	200
Milk	5	12	---	17
Spices	2	6	2	10
Lard	4	6	12	22
Cream Tartar	---	---	1	1
Coffee	4	1	3	8
Total	223	47	22	292
Total from all sources	865	388	94	1347

PART III.

COMMERCIAL FEEDING STUFFS.

BY E. H. JENKINS AND A. L. WINTON.

THE LAW REGULATING THEIR SALE.

Section 4591 of the general statutes of Connecticut so defines the term "concentrated commercial feeding stuff" that it covers practically all feeds *excepting the following*:—hay and straw, whole seeds, unmixed meal made directly from any one of the cereals or from buckwheat, and feed ground from whole grain and sold directly from manufacturer to consumer.

Section 4592 requires that every package of concentrated commercial feeding stuff shall bear a statement giving the name and address of manufacturer or importer, the number of net pounds in the package, the name of the article and the percentages of protein and fat contained in it.

Section 4593 requires every manufacturer, importer, agent, or seller to file with this station, upon request, a certified copy of the statement above described.

The penalty prescribed for violation of the foregoing sections is not more than \$100 for the first offense and not more than \$200 for each subsequent offense.

Section 4595 authorizes this station to take samples from any manufacturer, importer, agent, or dealer in a prescribed fashion and requires this station to analyze, annually, at least one sample of each brand which it has collected and to publish these analyses in station bulletins, "together with such additional information in relation to the character, composition and use thereof as may be of importance."

The dairy commissioner is charged with the enforcement of the provisions of these sections of the statutes.

In compliance with these requirements the following report has been prepared.

SAMPLING OF COMMERCIAL FEEDING STUFFS.

During the fall of 1905, Mr. V. L. Churchill, the sampling agent of this station, visited fifty-four towns and villages of this state and took two hundred and sixty-four samples of feeds in the way prescribed by law. These samples have been examined chemically and microscopically and the results appear in the following pages with appropriate discussion.

There are also given analyses of feeds which were sent to the station for analysis by individuals. Other samples of feeds have been sent for microscopic examination by other stations.

EXPLANATIONS OF ANALYSES OF FEEDING STUFFS.

An analysis gives the percentage amounts of Water, Ash, Protein, Fiber, Nitrogen-free Extract and Fat.

Percentage Amount is the amount in 100. If the protein in a feed is 17.5 per cent., every 100 pounds of that feed contain 17.5 pounds of protein; and since a ton is twenty hundred pounds, a ton of the feed will contain twenty times' 17.5 or 350 pounds of protein.

Water. However dry a feeding stuff appears to be, it always contains a considerable and variable quantity of water which cannot be seen or felt, but which can be driven out by heat. The amount of water thus present in feeding stuffs is constantly changing with the temperature and moisture-content of the air about them, and accordingly no very close comparison of different feeds is possible unless the proportions of water they contain are known and comparison is made on perfectly dry or water-free substance.

Ash is what is left when the combustible part of a feeding stuff is burned away by heating to faint redness in a current of air. Besides sand, usually an accidental impurity, the ash consists chiefly of lime, magnesia, potash and soda, combined with chlorine and carbonic, sulphuric and phosphoric acids.

Protein is a general term which, as used here, includes all the nitrogenous materials of a concentrated feeding stuff, whatever their character may be. In such feeds the protein substances for the most part bear a general resemblance in composition and properties to the animal proteins, egg albumin (white of egg), flesh fibrin (lean meat), and milk casein (curd). It is from this protein of the food alone that the animal can make albumin, fibrin and casein. The nitrogenous materials are the most costly and the most valuable ingredients of concentrated commercial feeds, which should be bought chiefly for the protein which is in them.

Nitrogen-free Extract, sometimes called *Carbohydrates*, includes starch, gum, sugar and pectin bodies. They are readily extracted from the feeding stuff by water and dilute acid.

Fiber is the essential constituent of the walls of vegetable cells and is seen in a nearly pure state in cotton fiber or paper pulp. It is the most insoluble part of the vegetable substance and of subordinate value in the ration.

Ether Extract includes fat oil, solid fat, wax, chlorophyl (the green coloring matter of plants), and other coloring matters, in brief everything which can be extracted from the perfectly dry feeding stuff by absolute ether.

Regarding the uses of the above-named parts of feeds:

Water and *ash* need not be considered, for, while indispensable to stock, both are abundantly supplied in other ways than in commercial feeds.

Protein is an essential ingredient of the food of every animal, because from no other substance can the waste of muscles, tendons and the working tissues and membranes be renewed; nor can the casein of milk, the albumin and other constituents of the egg, nor new body substance of any sort be obtained by the animal from any other source than protein. The necessary elements from which the animal organism constructs these substances are yielded in available form only by protein. Without protein the animal can live but a short time.

Fiber and the *nitrogen-free extract*, on the other hand, cannot serve for building up the muscles and other parts of the growing animal and cannot directly restore the waste and wear of those parts of mature animals, because they are of a very different nature. They contain no nitrogen, an element which

enters into all the animal tissues (proteins), to the extent of some sixteen per cent. of their dry matter.

Fiber and *nitrogen-free extract* cannot restore the worn-out muscles or membranes of the animal any more than coal can be made to renew the used-up packing, bolts, valves, flues and gearing of a steam-engine. Proteins are to the ox or the man what brass and iron are to the machine, the materials of construction and repair.

But *fat*, *fiber* and *nitrogen-free extract* are to the animal very much what coal and fuel are to the steam-engine. Their consumption generates the power which runs the mechanism. Their burning (oxidation) in the blood of animals produces the results of life just as the combustion of coal in the fire-box of the steam-engine produces the motion and power of that machine. For this combustion in the system, digestible fat has more than twice the value of digestible nitrogen-free extract.

There is, however, this difference between the engine and the animal: The former may be stopped for repairs; the latter may run at a low rate, but if it be stopped it cannot resume work. Hence the repairs of the animal must go on simultaneously with its waste. Therefore, the material of which it is built must admit of constant replacement, and the dust and shreds of its wear and tear must admit of escape without impeding action. The animal body is as if an engine were fed not only with coal and water, but with iron, brass and all the materials for its repair, and also is as if the engine consumed its own worn-out parts, voiding them as ashes or as gas and smoke. Proteins, or the blood- and tissue-formers, are thus consumed in the animal, as well as the fat, fiber and nitrogen-free extract or fuel proper. The fact that proteins admit of consumption implies that when the proper fuel is insufficient, they may themselves serve as fuel. Such is the case, in fact. But, nevertheless, the two classes of substances have distinct offices in animal nutrition, and experience has proved that for each special case of animal nutrition a special ratio of digestible proteins to digestible fat, fiber and nitrogen-free extract is the best and most economical, and, within certain limits, is necessary.

THE USES OF ANALYSES OF FEEDING STUFFS.

These uses are several. First, by an analysis compared with the average of others, any buyer of a feed can see whether it is of the usual quality. Thus on page 170 the analysis of cotton seed meal, No. 15680 compared with the average of twelve analyses given on the same page, shows that its quality is much below average as regards protein, the most valuable ingredient.

Secondly, by an analysis compared with the manufacturer's guaranty the buyer can see whether in composition the feed meets what is claimed for it. Thus on page 176 the analyses of Chicago gluten meal show that the feed contains on the average about 6 per cent. less of protein than is called for by the manufacturer's guaranty.

Thirdly, an analysis often shows clearly whether or not the feed is adulterated and may indicate also the form of adulteration.

It also makes clear the composition of mixtures which are sold under names which either convey no meaning or convey a false impression.

Fourthly, comparison of analyses of a number of kinds of feed with their prices will greatly help in deciding whether any one of them is worth to the feeder what is asked for it. Too often the prices of feeds bear no relation to their real feeding value.

Lastly, the chief use of these tables by feeders should be as a guide to the skillful compounding of rations for farm animals. How this is done cannot be briefly explained within the limits of a bulletin. A knowledge of the principles of cattle feeding is essential, which should be gathered by studying books which treat of the principles of cattle-feeding and of the art of compounding rations.

DISCUSSION OF THE ANALYSES.

The microscopical and chemical work in connection with these analyses has been done by Dr. Winton or under his direction, with the coöperation of Messrs. Bailey, Kreider and Shanley; the results have been prepared for publication and discussed by the director.

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COTTON SEED MEAL.

Analyses on pages 170 and 171.

Of the twelve samples collected by the station, nine fail to meet the manufacturer's minimum guaranty,* as appears in the following statement:—

	Percentage Amounts of			
	Protein.	Fat.		
	Found.	Guar- anteed.	Found.	Guar- anteed.
Chapin & Co., Green "Diamond" brand....	37.9	43.0	7.8	9.0
.....	41.0	43.0	8.0	9.0
Cox & Co., Magnolia brand.....	42.0	43.0	8.1	9.0
Georgia Cotton Oil Co. ....	.....	.....	7.2	8.0
Humphreys, Godwin & Co., Dixie brand	40.0	41.0	8.0	9.0
W. A. Keiser & Co., Eagle brand.....	41.4	43.0	..	..
Hunter Bros.	40.0	43.0	8.5	9.0
J. T. & R. S. Wells, Star brand.....	41.3	43.0	6.3	9.0
.....	39.8	43.0	6.8	9.0

The cause of this unusual discrepancy may be found in the fact that the meal of 1904 crop contains considerably less protein and fat and correspondingly more fiber and non-nitrogenous extract than in other years and that the mills have not allowed for this in their guaranties. It is also stated that it is not found profitable to remove the hulls as completely as formerly and it is quite likely that from now on cotton seed meal will run considerably lower in protein than it has heretofore.

The average percentage of nitrogen found in 157 samples bought in the spring of 1905 for fertilizers was 6.93. The average percentage of nitrogen in twelve samples bought in the fall of 1905 for feed is 6.52.

The average percentages of protein and fat, as determined at this station, and the average prices, quoted by retailers, at the time the samples were drawn, have been as follows for the last seven years:

	1899	1900	1901	1902	1903	1904	1905
Number of Samples.....	10	4	6	8	25	17	12
Percentage of protein ...	46.4	43.9	44.4	43.0	43.2	43.4	40.75
“ “ fat	10.4	8.6	9.8	10.3	9.2	9.6	8.02
Average price	\$24.00	27.00	28.80	20.70	20.04	28.88	28.80

* In this report the protein in a feed is considered in substantial agreement with the guaranty if it is not more than 0.7 per cent. below it. An allowance of one-tenth per cent. of nitrogen is made in comparing the actual and guaranteed composition of fertilizers (to cover possible errors of sampling and analysis), and as protein is calculated from nitrogen by multiplying by $6\frac{3}{4}$, an allowance about $6\frac{3}{4}$ times as large as that for nitrogen is made for protein.

The inferior quality of the present supply of cotton seed meal clearly appears in this comparison.

Cotton Seed Meal, sampled and sent by Purchasers.

Four samples from individuals were partially analyzed as follows:—

13421. Hunter Brothers. Sampled and sent by the Collinsville Grain Co. 13448, sampled and sent by R. G. Davis, New Haven. 13817. Bought of R. G. Davis, sampled and sent by A. H. Doolittle, Bethany. 13903. Sold by C. H. Fairty, sampled and sent by D. A. St. John, New Canaan.

ANALYSES.

	13421	13448	13817	13903
Water	7.71	....	....	....
Ash	7.10	....	....	....
Protein	42.62	42.56	42.25	43.12
Fat	9.02	....	....	....
Cost per ton .....	....	....	\$28.00	29.00

A single sample of Sea Island Cotton Seed Meal, 16078, sent by Meech & Stoddard, Middletown, contained 3.98 per cent. of nitrogen, equivalent to 24.87 per cent. of protein, with 1.61 per cent. of phosphoric acid and 1.74 of potash. It sells at \$22.00 per ton. When bright cotton seed meal sells at \$29.00 and contains 40.75 per cent. of protein, a meal containing but 24.87 per cent. of protein would be worth, as a source of protein, not more than \$17.70 per ton.

LINSEED MEAL.

Analyses on pages 170 and 171.

"Linseed Meal," "Oil Meal" and "Flax Seed Meal" are trade names for ground flax seed from which more or less of the oil has been removed. By the "old process" the oil is partly removed by pressure, leaving from 5 to 10 per cent. in the meal. By the "new process" the oil is so far extracted by naphtha as to leave, usually, less than 2½ per cent. in the meal. New process meal is rather more uniform in composition and contains more protein than old process meal.

One sample of new process and five of old process meal have been examined and all are of fair quality and unadulterated. A single sample, 15836, sold by Mann Bros., Buffalo, contains 32.7 per cent. of protein where 34.0 per cent. is guaranteed.

The average percentages of protein and fat found in linseed meal for the last four years, as determined at this station, with the average prices at the time the samples were drawn, as quoted by retailers, are as follows:

	New Process.				Old Process.			
	1902	1903	1904	1905	1902	1903	1904	1905
No. of Samples.....	4	2	3	1	6	9	11	5
Percentage of protein..	39.8	36.4	36.2	35.6	32.8	33.1	33.8	32.7
" " fat	2.1	3.2	3.1	2.8	7.8	7.5	7.1	7.1
Average price	\$31.00	32.50	28.33	32.00	32.00	30.77	31.45	32.00

While the term "oil meal" has been and still is used in the trade to refer only to linseed, there have been referred to this station for examination, three samples from other states of material sold as "oil meal" which contain no linseed at all, but are ground Dakota mustard seed cake containing other weed seeds.

Another sample of "linseed meal," thus referred, contains cocoa shells, obviously added as an adulterant.

RAPE SEED MEAL.

A sample of this material, consisting of the ground cake left after expressing the oil, was sent for an opinion of its value by a dairyman to whom it was offered, with a guaranty of 23.0 per cent. protein and 7.0 per cent. fat. Rape seed meal is somewhat used as feed for cattle in Europe. It is stated that great care is necessary in feeding it to cows, for some lots contain half a per cent. of oil of mustard, which spoils the flavor of the butter.

WHEAT PRODUCTS.

These are by-products in the manufacture of wheat flour. Several different processes of milling are in common use, yielding by-products which are not alike in composition.

Wheat Bran consists of the outer layers of the wheat berry, which are dark in color and do not easily pulverize.

Wheat Middlings, as found in the feed market, consist of inner layers of the covering of the berry, which are lighter in color and more easily pulverized than bran, and of other parts from which fine white flour cannot be made.

Many mills do not sell bran and middlings separately, but run them together, often with other waste wheat products, and sell the mixture as "Mixed Feed."

With few exceptions the samples of wheat feed described in the tables of analyses are not accompanied, as is required by law, with any statements of composition.

Bran from Winter Wheat.

Analyses on pages 170 and 171.

Nine analyses are given in the table. All the samples are pure and of good quality as regards chemical composition.

Bran from Spring Wheat.

Analyses on pages 170-173.

All of the sixteen samples examined appear to be pure wheat products, but some contain rather low percentages of protein. Thus six of them have not more than 13.5 per cent. of protein.

The Washburn-Crosby Co. is the only firm here represented which gives the guaranty as required by law.

The guaranty is 14.56 protein and 3.5 fat. The analyses of two samples show 13.62 and 14.19 of protein, 4.73 and 4.65 of fat.

Middlings from Winter Wheat.

Analyses on pages 172 and 173.

Only four samples have been analyzed, all of them pure and of good quality.

Middlings from Spring Wheat.

Analyses on pages 172 and 173.

Of the sixteen samples examined all are pure and of good quality, but only those made by the Washburn-Crosby Co. had the guaranty as required by law. This company guarantees 17.96 protein and 6.02 fat. The two analyses showed 16.75 and 17.25 per cent. of protein and 4.75 and 5.21 of fat.

Mixed Feed from Winter Wheat.

Analyses on pages 174 and 175.

Twenty-one samples have been examined. All are of fair quality. The American Cereal Co. is the only firm represented which gives a guaranty. This is 17.75 protein, 4.20 fat. The sample contained 16.12 protein and 4.53 fat.

Mixed Feed from Spring Wheat.

Analyses on pages 174-177.

Of the twenty-two samples examined, all of which were genuine and of fair quality, only two brands have the guaranty as required by law.

The Brooks Elevator Co. guarantees protein 16.0, fat 5.0. The feed contains protein 14.12, fat 4.3.

C. M. Cox Co.'s Wirthmore brand had a guaranty of protein 17.0, fat 4.0. The protein of three samples ranged from 14.25 to 16.44, and the fat from 3.64 to 4.81.

AVERAGE COMPOSITION AND PRICE OF WHEAT FEEDS IN CONNECTICUT,
1899 TO 1905.

1899	Winter.	Bran. Spring.	Middlings. Winter.	Spring.	Mixed Feed Winter.	Spring.
Protein	15.9	15.6	15.8	15.6	16.8	16.8
Fat	4.3	4.7	4.4	4.7	4.5	5.1
Ton price	\$19.80	19.14	19.00	19.25	19.44	19.25
1900						
Protein	16.1	16.5	17.7	19.1	18.1	17.6
Fat	4.6	5.0	4.7	5.5	4.7	5.3
Ton price	\$21.09	20.00	21.00	21.50	21.00	20.80
1901						
Protein	16.3	17.3	18.0	19.7	17.5	18.5
Fat	4.5	4.7	5.0	5.5	4.7	5.1
Ton price	\$21.80	21.06	22.75	22.10	22.20	22.20
1902						
Protein	17.1	16.7	18.1	19.2	17.7	17.7
Fat	4.6	4.9	4.4	5.4	4.6	5.1
Ton price	\$23.37	20.90	23.85	23.44	22.00	22.35
1903						
Protein	15.5	15.9	16.4	17.9	16.7	16.9
Fat	4.5	4.9	4.5	5.0	4.5	5.0
Ton price	\$23.00	22.50	25.55	25.50	23.55	23.53
1904						
Protein	15.0	15.5	16.5	17.1	16.0	16.3
Fat	4.4	4.7	4.6	5.0	4.5	4.7
Ton price	\$26.13	24.57	28.14	26.60	25.83	26.07
1905						
Protein	15.2	14.1	16.4	16.8	15.7	15.1
Fat	4.6	4.7	4.5	4.8	4.5	4.5
Ton price	\$21.22	21.13	23.12	23.31	22.70	22.86

In 1905 there was little difference in composition between the winter and spring wheat products, except that spring wheat bran had a per cent. less protein than winter wheat bran. There was less difference also in the prices of winter and spring wheat products, all of which ruled from three to five dollars per ton lower than in 1904.

The percentages of protein in bran, middlings and mixed feed are lower than they were a few years ago. This may be due to the composition of the wheat crop or to some change in milling processes.

The following wheat products sent by individuals have also been examined:

15875. Elmco Standard Middlings, from S. Heath, New Canaan. Protein found, 17.06, guaranteed 20.0.

13455. Columbia Feed, sent by W. H. Lee, Orange. Protein 14.87.

14001. Bran from W. H. Lee, Orange. Protein found 14.00.

16079. Mixed feed from W. H. Lee, Orange. Protein 16.37.

14451. Go-far Standard Middlings. Made by New Prague Flouring Mills. Sampled and sent by Harriet L. Merrow, Merrow. Protein found, 15.75 per cent.

13956. Feed sent by Abner Hendee, New Haven. Protein 10.75 per cent. Contains ground corn-cobs.

15923. Huron Mixed Feed made by Flint Mill Co., Milwaukee. Sampled and sent by G. M. White & Co., East Hartford Meadow.

13275. Mixed Feed made by Aug. J. Bulte Milling Co., Kansas City. Sampled and sent by Arthur Sikes, Suffield.

15918. Bran sold by Abner Hendee. Sampled and sent by W. H. Lee, Orange.

ANALYSES.

	15923	13275	15918
Water	8.96	10.05	8.97
Ash	4.85	5.45	6.80
Protein	15.37	16.25	17.25
Fiber	7.25	7.59	8.97
Nitrogen-free Extract	58.97	56.04	53.39
Fat	4.60	4.62	4.62
	100.00	100.00	100.00

MAIZE MEAL.

Analyses on pages 176 and 177.

All of the seven samples analyzed are of fair quality and old crop, the highest percentage of water being 13.24. Sample 15781, made by the Buffalo Cereal Co., contains more fat and protein and less starch than whole corn usually contains. Probably it is corn meal mixed with corn germ. The average

percentage of protein in these samples is 8.96 (or 10.19 per cent. in the water-free material) and the average price is \$25.35 per ton. This is relatively a low grade, high-priced feed. It is possible to breed corn which, while yielding more bushels per acre than farmers are getting now, will also contain a good deal more protein to the bushel. This work of improving our flint, dent and sweet varieties is now engaging the attention of this station.

A sample of Pop Corn Waste, 15129, sent by E. H. Austin, Gaylordsville, has the following composition:

Water	10.52
Ash	1.66
Protein	11.56
Fiber	2.33
Nitrogen-free Extract	69.38
Fat	4.55
	100.00

GLUTEN MEAL.

Analyses on pages 176 and 177.

Two brands of gluten meal were found in our market in the fall of 1905.

The Chicago Gluten Meal, made by the Glucose Sugar Refining Co., Chicago, has an average of 31.93 per cent. of protein and 5.5 per cent. of fat,—nearly two per cent. less of protein than last year and six per cent. less than is guaranteed. The manufacturers guaranteed 38 per cent. of protein and 3 per cent. of fat in this feed, but we are informed that the manufacture has now ceased and the factory has been dismantled.

Cream Gluten made by the Illinois Sugar Refining Co., Chicago, contains 32.68 per cent. of protein and 4.81 per cent. of fat. 35.50 per cent. of protein and 3.0 per cent. of fat are guaranteed, so that in composition this brand also falls far short of the manufacturer's claim, and the guaranty is misleading.

GLUTEN FEED.

Analyses on pages 176-181.

Eleven different firms offer brands of this popular dairy feed.

American Cereal Co., Chicago. A single sample contains 24.00 per cent. of protein and 4.75 of fat, instead of 28.0 of protein and 3.0 of fat, which are guaranteed.

Buffalo Cereal Co., Buffalo. The protein in four samples ranges from 22.9 to 25.4. The average is 24.23 per cent. of protein, instead of 28.0 per cent. guaranteed.

Peoria Cereal Co., Peoria, Ill., Continental Gluten Feed. The gluten feed made by this firm has the highest percentage of any of the brands, 28.75, but this is more than six per cent. lower than is claimed by the manufacturer, viz: 35 per cent. The material contains corn, oat and barley residues and is a distillery product, not a residue from glucose or starch manufacture. Its digestible portion is, therefore, calculated as for distillery grains. A sample, 13913, sent by T. S. Gold, West Cornwall, contained 32.37 per cent. of protein. Another sample, 13945, sent by Edwin C. Davis, Somers, had the following composition:

Water	6.03
Protein	31.00
Fat	12.77

Douglas & Co., Cedar Rapids, Iowa. A single sample contains 18.75 per cent. of protein, whereas 26.5 per cent. is guaranteed.

Flint Mill Co., Milwaukee. The average percentage of protein found in two samples is 19.68 as against 25 per cent. guaranteed. A sample of this brand, 13818, sent by R. W. Jennings, Torrington, contains 26.25 per cent. of protein.

Glucose Sugar Refining Co., Chicago. Buffalo Gluten Feed. The percentage of protein in eleven samples ranges from 21.37 to 26.25, the average being 24.38 and the guaranty 25.0.

Only three of the eleven samples fell distinctly below the manufacturer's guaranty in respect to protein, and this and the Globe Gluten Feed made by the New York Glucose Co. are the only brands of gluten feed found in the Connecticut market this year which meet the guaranties of their manufacturers. A single sample, 15917, sent by W. H. Lee, Orange, bought of Abner Hendee, New Haven, contains protein 23.62 per cent., fat 3.95 per cent.

J. C. Hubinger Bros. Co., Keokuk, Iowa. The average protein found in four samples is 24.20 per cent; guaranteed 26.00 per cent.

National Starch Co., Chicago. Queen Gluten Feed. The protein found in the single sample is 22.00 per cent.; guaranteed 25.0.

New York Glucose Co. Globe Gluten Feed. The percentage of protein in ten samples ranges from 26.25 to 29.25, the average being 26.99 and the guaranty 26.0. This brand and the Glucose Sugar Refining Co.'s Buffalo Gluten Feed are the only ones found in the Connecticut market this year which meet the manufacturer's guaranties.

J. E. Soper & Co.'s Bay State. The average percentage of protein in four samples is 18.54, instead of 26.0, as guaranteed. This brand and that of Douglas & Co., Cedar Rapids, and of the Flint Mill Co., contain less than 20 per cent. of protein, though 25 and 26 per cent. of protein are guaranteed.

Warner's Sugar Refining Co., Waukegan, Ill. The average percentage of protein in four samples is 21.98. The amount guaranteed is 25.0.

Two samples of gluten feed, 14002, brand unknown, and 16080, Buffalo gluten sent by W. H. Lee, Orange, contain 22.75 and 23.50 per cent., respectively, of protein, and one of Tiger Gluten Feed, 14017, sent by S. A. Smith & Son, Clintonville, made by the St. Louis Syrup & Preserving Co., contains 22.87 per cent. of protein, instead of 25.0 guaranteed. Another sample of gluten feed, 16081, from Abner Hendee, contains 23.75 per cent. of protein.

HOMINY FEED.

Analyses on pages 180 and 181.

This material, also called "Hominy Chop" and "White Meal," is a by-product from hominy mills and breweries and is quite popular with dairymen.

Hominy Feed, with the names of the following firms upon the bags, did not bear the statement of composition which is required by the law concerning feeding stuffs: M. F. Berlinger, Philadelphia; The Coles Co. and Meech & Stoddard, Middletown; Hollister, Chase & Co., Simpson, Hendee & Co.

and William R. Payne & Son, New York, and J. S. Wolfe Co., Pittsfield, Mass.

The Hominy Feed sold by Suffern, Hunt & Co., contains considerably less protein, 9.75 per cent., than is guaranteed, 11.00 per cent.; the other brands meet fairly well the manufacturers' guaranties.

Several samples of Hominy Feed sent by individuals had the following composition:

13425, from F. B. Newton, Plainville. 13893, sold by Chapin & Co., Boston, sent by T. A. Stanley, New Britain. 13910, Hominy Chop, and 13909, Star Hominy Chop, made by Toledo Elevator Co., sent by Meech & Stoddard, Middletown. 13953, Star Feed, made by the Toledo Elevator Co., sent by A. L. Hitchcock, Plainville. 14130, "A by-product from cracked corn," sent by R. G. Davis, New Haven.

ANALYSES.

	13425	13893	13910	13909	13953	14130
Water .....	....	8.93	....	....	....	....
Ash .....	....	3.34	....	....	....	....
Protein	10.37	9.06	10.06	9.00	8.63	8.81
Fiber .....	....	7.29	....	....	....	....
Nitrogen-free Extract ..	....	64.68	....	....	....	....
Fat	7.48	6.70	....	....	....	....
		100.00				

The Star Chop apparently contains a larger proportion of cob than the average hominy chop.

RYE FEED.

Analysis on pages 182 and 183.

Seven analyses are given in the table. All of the samples are pure and of fair average quality, but none of them has the guaranty of composition required by law.

The prices, all of which were quoted in October last, range from \$22.50 to \$28.00 per ton.

At the latter price rye feed could not be economically used at present.

MALT SPROUTS.

Analysis on pages 182 and 183.

The two samples examined, neither having the required guaranty, have about the usual composition.

DRIED DISTILLERY GRAINS.

Analyses on pages 182 and 183.

Ajax Flakes.—This material is the grains from which starch and sugar have been largely removed by “mashing” in the distilleries and which have then been dried.

In the three samples examined the average percentage of protein found is 30.89, guaranteed 33.0. Average fat found 13.35, guaranteed 12.0. Two of the “Dairy Feeds” noticed on pages 186 and 184, namely 15768, Empire State Dairy Feed, and 15591, Biles Dairy Feed Fourex Grains, are also dried distillery grains, which have proved to be an excellent dairy feed.

A sample, 13920, marked *Protein Corn Distillers Grains* from C. F. Keck & Co., Milwaukee, Wis., has the following composition:—

Water	11.77
Ash	1.87
Protein	26.56
Fiber	10.21
Nitrogen-free Extract	39.34
Fat	10.25
	100.00

BUCKWHEAT MIDLINGS.

Analysis on pages 182 and 183.

This material, made in this state, maintains its usual quality as a high protein feed, selling at a very reasonable price, \$22.00 per ton.

A sample of Birkett Buckwheat Feed, 13435, sent by Meech & Stoddard, Middletown, contains only 12.87 per cent. of protein and another sample, sent by Thomas Holt, Southington, contains but 9.81 per cent. These contain a large amount of hulls, which are nearly worthless as feed.

The Buckwheat Middlings are free from them.

ALFALFA MEAL.

Analysis on pages 182 and 183.

This material appears to be true to name and to be dried and ground alfalfa hay. It contains 20.25 per cent. of protein

and is offered for \$38.00 per ton. Cotton seed meal, containing pound for pound twice as much protein, sells for \$28-\$30. The price of this alfalfa meal is, therefore, out of all proportion to its value as a dairy feed.

MISCELLANEOUS MIXED FEEDS.

Various Corn and Oat Feeds.

Analyses on pages 182 and 183.

These are mixtures of factory waste products, sold under various proprietary names, some of them containing a considerable amount of oat hulls.

The protein in them ranges from 8.00 to 9.75 and the woody fiber from 3.87 to 12.24.

No guaranty is given by the Husted Mill and Elevator Co. The other brands are sold with guaranties, which in all cases are substantially justified by the composition of the goods.

A sample of Victor Feed, 13437, sent by Dr. Geo. E. Corwin, Jr., Lakeville, contains 7.81 per cent. of protein.

Corn and Wheat Feeds.

Analysis on pages 182 and 183.

Mixtures of Corn and Wheat.

Colonial Choice Middlings, made by Miner-Hillard Mill Co., Wilkes Barre, Penn., is a mixture of wheat and corn products containing no undue proportion of cob and meets the manufacturer's guaranty.

Mixtures of Corn-Cobs and Wheat Feed.

Analyses on pages 182-185.

Dairy Mixed Feed manufactured for Jennings & Fulton, Boston, is stated to be a mixture of winter wheat bran, winter wheat ship stuff and corn cob meal.

The average percentages of protein and fat in the three samples examined are 11.16 and 3.07, respectively. The guaranty is 12.05 protein and 3.20 fat.

Jersey Mixed Feed and *Indiana Mixed Feed* made by the Indiana Mill Co., Terre Haute, have the same guaranty as the above, and the same statement of ingredients.

A single sample of *Blue Grass Mixed Feed*, manufacturer not stated, contains but 10.75 per cent. of protein, while 12.50 per cent. is guaranteed.

Corn, Oats and Barley.

Analyses on pages 184 and 185.

Analyses of two brands appear in the table. That made by the Husted Mill and Elevator Co. is sold without guaranty. Schumacher's Stock Feed, made by the American Cereal Co., substantially meets its guaranty of 12 per cent. protein and 4.0 per cent. of fat.

Proprietary Horse Feeds.

Analyses on pages 184 and 185.

Sucrene Horse Feed, made by American Milling Co., Chicago, Ill., is a mixture of wheat, oat, corn, barley and other products, with some linseed meal. The guaranty is 13.50 per cent. of protein and 3.50 of fat. Two samples analyzed contains 11.87 and 12.62 per cent. of protein and 2.48 and 2.64 per cent. of fat, respectively.

Horse Feed, made by the Buffalo Cereal Co., Buffalo, N. Y., is a mixture of oats, cracked corn, wheat bran and linseed meal and substantially meets the owner's guaranty.

Horse Feed, made by the H. O. Co., Buffalo, N. Y., is a mixture of corn, oats (or oat hulls), wheat bran and peanuts, and meets the manufacturer's guaranty.

Proprietary and other Dairy and Stock Feeds.

Analyses on pages 184 and 185.

A considerable number of brands of these feeds have been examined, of all degrees of concentration, the protein in them ranging from 8.25 to 32.00 per cent.

With the exception of that sold by the Daniels Mill Co., all have a guaranty of composition, as required by law.

The following brands contain considerably less protein than is guaranteed.

	Guaranteed.	Found.
Quaker Dairy Feed.....	14.0*	11.75
Biles' Union Grains.....	24.0	22.00
Dickinson's Stock Food.....	10.0	8.25
Clark Bros. & Co.'s Empire State Dairy Feed..	36.2	29.50
Lenox Stock Feed.....	9.9	8.50
Hammond Dairy Feed.....	17.0	14.62

* Reduced December 1 to 12.0 per cent.

These dairy and stock feeds are mixtures of a great variety of products or factory wastes. In such a ground mixture it is usually impossible to say whether the ingredients used are sound, saleable products, or are damaged and waste articles. The following list shows the various ingredients found by microscopic examination of the feeds. *Quaker Dairy Feed*, oat and wheat products, cotton seed meal, trace of corn. *Sucrene Dairy Feed*, wheat, corn, barley and oat products, cotton seed meal and some weed seeds. *Biles Fourx Grains*, and *Clark Bros. & Co.'s Empire State Dairy Feed*, maize, barley, oat and rye residues. They are dried distillery grains. *Biles Union Grains*, maize, oat, barley and rye residues, with wheat bran, malt sprouts, cotton seed and linseed. *Buffalo Cereal Co.'s Creamery Feed*, corn and oat products and cotton seed meal. *3X Stock Feed*, *Daniels Mill Co.'s Stock Feed*, *H. O. Mills, New England Stock Feed*, corn, oats and wheat products. *Durham Stock Feed*, *Haskell's Stock Feed*, corn and oat feed. *Great Western Cereal Co.'s Excelsior Stock Feed*, *Dickinson's Stock Feed*, *Lenox Stock Feed*, cracked corn and oat product. *Blatchford's Calf Meal*, cotton seed, linseed, beans, carob-beans, wheat product and fenugreek. *H. O. Dairy Feed*, corn, oat and wheat products and cotton seed meal. *Protena Dairy Feed*, wheat bran, corn product, cotton seed meal and ground hay, with characters of alfalfa. *Hammond Dairy Feed*, malt sprouts and other barley product, oat and maize products and weed seeds.

A sample of *Quaker Dairy Feed*, 13921, sent by C. C. Chapin, Thompsonville, contained moisture 7.13, protein 12.13, fat 3.55 per cent. which is about the usual composition of this brand.

A sample of *Sucrene Dairy Feed*, 15128, sent by F. B. Ashton, Middletown, containing 15.31 per cent. of protein, was by a clerical error reported as containing only 6.31 per cent.

Proprietary Poultry Feeds.

Analyses on pages 186 and 187.

Six brands of poultry feeds have been examined. *American Cereal Co.'s Poultry Feed* contains corn, a wheat product and cotton seed meal. *Buffalo Cereal Co.'s Poultry Feed*, rolled

oats, cracked corn, wheat bran. *H. O. Co.'s Poultry Feed*, cracked corn, rolled oats, wheat bran and peanuts. *Purina Chick Feed*, screenings (containing wheat, wild mustard, black bindweed, foxtail and cockle), cracked white Kafir corn, or a related variety of sorghum, millet and cracked corn. *Daniels Mill Co.'s Chick Food*, millet, cracked corn, wheat and grit. *Cyphers Incubator Co.'s Laying Feed*, wheat bran and coarse corn meal. A sample marked "Poultry Food," without the name of brand or manufacturer, sent by H. L. Jeffrey, New Preston, contains 14.75 per cent. of protein and 14.46 per cent. of salt. It is composed of wheat bran, with a little linseed, cayenne pepper and salt and possibly other ingredients.

Beef Scrap and Meat Meal.

Analyses on pages 186 and 187.

These samples have the usual composition of such material.

THE DIGESTIBILITY OF FEEDING-STUFFS.

A certain part of every feeding-stuff is indigestible and passes through the body into the dung without doing anything to sustain the animal. The value of a commercial feed rests wholly in that portion of it which the animal can, under favorable conditions, digest or appropriate and make a part of itself. Some animals have greater power of digestion than others, and the amount of any ingredient, protein, fat, or fiber, digested by a given animal depends much on the proportion of other ingredients which are fed along with it. Thus, if starchy matter is fed in too large proportion, a considerable part of it will pass into the dung and be wasted. But fed in proper fashion over 90 per cent. of it may be taken up by the body and nourish it.

Table I gives the "digestion coefficients" of most of the feeds mentioned in Table IV.

The digestion coefficient of protein, for example, in cotton seed meal is 88. This means that in a properly made ration, neat cattle, in good health, may be expected, on the average, to digest about 88 parts out of every 100 parts of the protein of cotton seed meal of good quality. The table has no great mathematical precision, but is, nevertheless, a valuable general guide in feeding.

The use of the table is quite simple. Suppose analysis shows a certain sample of cotton seed meal to contain 43.5 per cent. of protein; that is, 43.5 pounds of protein in 100 pounds of the meal. It is desired to know how much *digestible* protein is contained in 100 pounds of meal. The table of "digestion coefficients" shows that of every 100 pounds of crude protein in cotton seed meal 88 pounds are digestible. It follows, by the rule of three. (100 is to 88 as 43.5 is to 38.28), that, of the 43.5 pounds of protein, 38.28 pounds are digestible. To apply the table, multiply the percentage found on analysis by the proper coefficient taken from the table and divide the product by 100. The result will be the percentage amount of *digestible* protein, fiber, etc., as the case may be.

In Table IV, under the averages of analyses, will be found calculated the average digestible nutrients contained in the different feeding-stuffs, so far as the data at hand permit.

TABLE I.—DIGESTION COEFFICIENTS, OR PERCENTAGES OF THE FOOD INGREDIENTS, FOUND BY ANALYSES, WHICH ARE DIGESTIBLE BY NEAT CATTLE.

(Lindsay's Compilation, Fourteenth Report Massachusetts (Hatch) Agricultural Station 1902, page 195.)

	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
Cotton Seed Meal.....	88	32	64	93
Linseed Meal, new process..	85	74	84	93
Linseed Meal, old process...	89	57	78	89
Corn Meal*	70	..	94	91
Gluten Meal	84	..	88	98
Gluten Feed	85	76	89	83
Wheat Bran	77	21	69	66
Wheat Middlings	77	30	78	88
Wheat Mixed Feed.....	77	26	74	77
Rye Meal	84	..	92	64
Malt Sprouts	80	34	69	100
Dried Distillers' Grains....	74	..	82	95
H. O. Dairy Feed.....	78	41	70	85
Quaker Oat Feed.....	81	43	67	89
Quaker Dairy Feed.....	78	41	70	85
Corn and Oat Feeds.....	71	48	83	87

* Also assumed for hominy feeds.

REGARDING THE PURCHASE OF COMMERCIAL FEEDING-STUFFS.

A well-managed dairy farm should produce all of the coarse fodder,—in form of corn fodder or stover, hay and ensilage,—which is needed for the stock, and, excepting under unusual conditions, should also supply an abundance of starchy food, such as corn meal and in some cases oats and barley, for feeding purposes.

These the farmer should be able to produce in abundance.

But in order to feed them without waste and also to supply a deficiency in them, it is almost always advisable or necessary, in the absence of clover, alfalfa, or other leguminous crops, to buy feeds *rich in digestible protein*;—considerably richer in it than corn meal.

The analyses given on following pages show what feeds are at present on our market, which of them meet this demand for digestible protein at reasonable prices and which of them do not meet this demand and cannot be fed to advantage.

The main facts given in Table IV are summarized in Table II, which shows, first, the average composition of these feeding-stuffs as determined by our recent examination and arranged according to the per cent. of protein in them; second, the amount of digestible matter in each feed, as far as we have been able to calculate it, and third, the average retail prices of the feeds in October and November last.

The table divides the commercial feeds into five classes.

1. Those having over 30 per cent. of protein in them:—Cotton seed, linseed and gluten meals, dried distillers' grains and buckwheat middlings.

Their average price is \$29.24 per ton and average protein 33.3 per cent.

2. Feeds having between 20 and 30 per cent. of protein:—Certain gluten feeds, some brands of distillers' grains, alfalfa meal and certain proprietary dairy feeds.

Alfalfa meal is excluded from the averages, on account of the price, which is prohibitive. These feeds have an average cost of \$26.61 and contain an average of 24.6 per cent. protein.

3. Feeds having between 15 and 20 per cent. of protein:—
Certain gluten feeds, middlings, mixed feed and winter bran, and some proprietary dairy feeds.

Their average price is \$24.74 and their average percentage of protein 17.1 per cent.

4. Feeds having between 10 and 15 per cent. of protein:—
Spring bran, hominy feed, and various proprietary feeds.
The average price is \$24.17 and average percentage of protein 12.2.

5. Feeds with less than 10 per cent. of protein:—Corn meal, mixtures of corn and oats (hulls) and a considerable number of "stock feeds," which are essentially mixtures of corn and oats. These cost on the average \$23.70 per ton and contain an average of 8.8 per cent. of protein.

The table shows that feeds are bought and sold at prices which bear no just relation to their feeding value.

Thus, it is not difficult to select feeds selling at about the same price, one of which contains twice as much protein as the other.

The whole class of feeds which contain on the average 23.8 per cent. of protein costs on the average only \$3.00 per ton more than that class of feeds which contains but 8.8 per cent. of protein.

In most cases a feeder cannot use to advantage any boughten feed containing less than 15 per cent. of protein.

Ready mixed feeds, made of a number of by-products or factory wastes, may wisely be let alone, unless the buyer can see for himself out of just what raw material the mixture is being prepared. Low grade, damaged corn, shriveled wheat, peanut refuse and wheat screenings containing many weed seeds, are not infrequently found in such feeds by careful examination, but are not easy for the buyer himself to recognize.

TABLE II.—AVERAGE COMPOSITION OF FEEDS IN CONNECTICUT MARKET
DIGESTIBLE MATTER IN THEM AND SELLING PRICE.

	In 100 pounds of feed are contained pounds of						In 100 pounds of feed are con- tained pounds of digestible				
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract (Starch, etc.).	Ether Ex- tract (fat).	Protein.	Fiber.	Nitrogen-free Extract.	Fat.	Cost per ton.
<i>Containing over 30 per cent. protein.</i>											
Cotton Seed Meal	8.9	6.3	40.8	9.3	26.7	8.0	35.9	3.0	17.1	7.5	\$28.85
Linseed Meal, new process	11.0	5.3	35.6	9.2	35.8	3.1	30.3	6.8	30.1	2.8	32.00
" old process	10.5	5.4	32.7	8.5	35.8	7.1	29.1	4.8	27.9	6.4	32.00
Cream Gluten Meal	9.0	1.7	32.7	2.0	49.8	4.8	27.4	--	43.8	4.7	33.00
Chicago "	9.1	1.8	31.9	2.3	49.4	5.5	28.4	--	45.9	5.1	31.75
XXXX Dairy Feed	7.7	2.2	31.2	11.9	35.5	11.5	23.1	--	29.2	10.9	27.00
Dried Distillery Grains	7.5	2.0	30.9	12.6	33.6	13.4	22.9	--	27.6	12.7	27.35
Buckwheat Middlings	11.9	5.8	30.9	8.6	34.3	8.5	--	--	--	--	22.00
<i>Containing 20 to 30 per cent. of protein.</i>											
Empire State Dairy Feed	7.4	2.2	29.5	12.9	36.4	11.6	21.8	--	29.9	11.0	27.00
Continental Feed	7.7	3.5	28.8	10.6	37.6	11.8	21.3	--	30.9	11.2	28.00
Gluten Feed, Globe	9.2	3.1	27.0	7.4	50.2	3.1	22.9	5.7	44.7	2.6	25.80
Malt Sprouts	9.2	6.0	25.7	10.7	46.5	1.9	20.5	3.6	32.2	1.9	20.50
Gluten Feed, Buffalo	9.0	1.8	24.4	7.0	54.4	3.4	20.7	5.3	48.5	2.8	26.55
" Buffalo Cereal Co.	9.7	2.5	24.2	7.3	52.8	3.5	20.6	5.6	47.0	2.9	27.00
" Hubinger's	8.0	1.7	24.2	7.7	55.2	3.2	20.6	5.8	49.0	2.6	26.75
" Am. Cereal Co.	9.8	2.6	24.0	7.3	51.5	4.8	20.4	5.5	45.9	3.9	27.00
Dairy Union Grains	8.9	6.7	22.9	8.8	45.4	7.2	--	--	--	--	28.00
Gluten Feed, Queen	11.2	1.1	22.0	7.1	55.9	2.7	18.7	5.4	49.9	2.2	28.00
" Warner's	9.1	1.7	22.0	7.2	50.3	3.7	18.8	5.5	50.1	3.1	25.75
H. O. Dairy Feed	8.7	3.9	20.3	12.3	56.0	4.8	15.8	5.0	35.0	4.1	29.00
Alfalfa Meal	10.0	12.3	20.3	18.6	36.6	2.2	--	--	--	--	38.00
<i>Containing 15 to 20 per cent. of protein.</i>											
Gluten Feed, Flint	8.9	1.1	19.7	6.4	59.0	4.9	16.7	4.8	52.6	4.1	27.00
Creamery Feed, Buffalo Cereal Co.	8.9	4.2	19.6	11.8	50.8	4.7	--	--	--	--	26.00
Protena	9.1	7.6	19.1	17.6	42.9	3.7	--	--	--	--	26.00
Gluten Feed, Cedar Rapids	8.5	0.9	18.8	7.6	58.8	5.4	15.9	5.7	52.4	4.5	29.00
" Bay State	9.8	1.0	18.5	5.3	61.3	4.1	15.8	4.1	54.5	3.4	25.75
Wheat Middlings, Spring	11.3	4.7	16.8	6.0	56.3	4.9	12.9	1.8	43.9	4.3	23.31
" Winter	11.0	4.3	16.4	5.6	58.2	4.5	12.7	1.7	45.4	4.0	23.12
Rye Feed	12.3	3.7	15.8	3.8	61.3	3.1	13.3	--	56.3	2.0	23.93
Mixed Feed, Winter	11.0	5.8	15.7	7.6	55.4	4.5	12.1	2.0	41.1	3.5	22.70
Bran, Winter	10.5	6.7	15.2	8.8	54.2	4.6	11.7	1.8	37.4	3.0	21.22
Mixed Feed, Spring	10.9	4.9	15.1	7.5	57.1	4.5	11.6	2.0	42.3	3.5	22.86
Sucrene Dairy Feed	11.4	6.2	15.0	8.6	55.1	3.7	--	--	--	--	26.00
<i>Containing 10 to 15 per cent. of protein.</i>											
Hammond Dairy Feed	10.7	7.1	14.6	9.5	54.4	3.7	--	--	--	--	25.00
Bran, Spring	10.9	6.3	14.1	10.5	53.5	4.7	10.8	2.2	36.9	3.1	21.13
Colonial Middlings	11.4	3.5	13.1	5.6	60.0	6.4	--	--	--	--	26.00
H. O. Horse Feed	8.9	3.8	12.9	9.4	59.8	5.2	--	--	--	--	27.00
Sucrene Horse Feed	12.2	6.7	12.2	8.0	58.3	2.6	--	--	--	--	27.00
Quaker Dairy Feed	9.3	5.3	11.8	17.6	52.9	3.1	--	--	--	--	21.00
Horse Feed, Buffalo Cereal Co.	9.8	3.7	11.5	10.3	59.6	5.1	--	--	--	--	26.00
Various Mixtures of Wheat Feed and Corn Cob	10.1	4.9	11.2	14.7	56.1	3.0	--	--	--	--	20.71
Hominy Feed	9.6	2.8	10.2	5.2	64.2	8.0	7.1	--	60.3	7.3	23.88
XXX Stock Feed	9.2	3.9	10.1	11.8	59.6	5.4	--	--	--	--	24.00

TABLE II.—AVERAGE COMPOSITION OF FEEDS IN CONNECTICUT MARKET, DIGESTIBLE MATTER IN THEM AND SELLING PRICE.—*Continued.*

	In 100 pounds of feed are contained pounds of						In 100 pounds of feed are contained pounds of digestible				
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract (Starch, etc.)	Ether Extract (fat)	Protein.	Fiber.	Nitrogen-free Extract.	Fat.	Cost per ton.
<i>Containing less than 10 per cent. of protein.</i>											
Daniels' Stock Feed	12.5	2.1	9.9	4.8	67.2	3.5	7.0	2.3	55.8	3.1	\$26.00
New England Stock Feed	9.8	3.2	9.1	10.4	63.0	4.5	6.5	5.0	52.3	3.9	24.00
Haskell's "	7.5	3.6	9.0	8.8	64.3	6.8	6.3	4.2	53.3	5.9	25.00
Cord Meal "	12.1	1.4	9.0	1.9	71.6	4.0	6.3	--	67.4	3.6	25.35
Excelsior Stock Feed	8.6	5.9	8.6	12.2	58.4	6.3	6.1	5.9	48.5	5.5	22.00
Lenox "	11.7	3.1	8.5	9.1	64.7	2.9	6.0	4.4	53.6	2.6	25.00
Durham "	10.4	4.8	8.3	12.7	57.8	6.0	5.9	6.1	47.8	5.2	24.00
Dickinson's "	10.5	3.3	8.3	11.1	63.1	3.8	5.9	5.3	52.4	3.3	20.00
Various other corn and oat feeds ..	10.3	3.2	8.8	8.2	64.9	4.6	6.2	3.9	53.8	4.0	24.20
Victor Corn and Oat Feed	10.5	3.8	8.1	10.3	63.4	3.9	5.8	4.9	52.5	3.4	21.50

THE WEIGHT OF ONE QUART OF VARIOUS FEEDING STUFFS.

The following table gives the weight of one quart of the feeds named, and is useful to calculate the weight of grain ration fed, from the measure which is almost universally used on farms.

This table was prepared by Mr. H. G. Manchester, of Winsted.

TABLE III.—THE AVERAGE WEIGHT OF ONE QUART OF EACH OF THE FEEDS NAMED.

	Pounds.
Cotton Seed Meal	1.5
Linseed Meal, old process	1.1
Linseed Meal, new process	0.9
Gluten Meal	1.7
Gluten Feed	1.4
Distillers' Grains	0.7
Wheat Bran, coarse	0.5
Wheat Middlings, coarse	0.8
Wheat Middlings, fine	1.1
Mixed Wheat Feed	0.6
Corn Meal	1.5
Hominy Meal	1.3
Provender	1.5
Oats	1.2
Rye Bran	0.6
H. O. Dairy Feed	0.7
Victor Corn and Oat Feed	0.7

SAMPLED IN 1905.

Station No.	ANALYSES.						Price per ton.
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Fat. (Ether Extract.)	
15680	9.87	5.41	37.87	11.45	27.60	7.80	\$29.00
15726	9.19	6.08	41.00	8.29	27.47	7.97	28.00
15626	8.06	6.78	42.00	8.08	26.95	8.13	28.00
15638	8.82	5.69	38.25	10.56	29.51	7.17	29.00
15631	8.98	6.40	40.00	9.62	27.00	8.00	29.00
15735	8.76	7.51	43.25	5.06	25.61	9.81	29.00
15765	8.84	6.12	41.44	8.89	25.50	9.21	30.00
15773	9.21	7.95	41.25	8.24	23.95	9.40	29.00
15688	8.61	5.80	43.00	10.09	25.29	7.21	30.00
15716	9.90	6.64	40.00	8.47	26.47	8.52	28.00
15709	8.51	5.69	41.25	11.57	26.71	6.27	29.00
15829	7.99	6.00	39.75	10.70	28.77	6.79	28.00
	8.89	6.34	40.75	9.25	26.75	8.02	28.89
	----	----	35.9	3.0	17.1	7.5	
15675	10.98	5.34	35.62	9.17	35.84	3.05	32.00
	----	----	30.3	6.8	30.1	2.8	
15737	10.17	4.96	33.87	8.03	36.54	6.43	32.00
15836	11.24	5.31	32.69	7.77	35.20	7.79	33.00
15683	10.90	6.03	29.69	9.67	36.78	6.93	31.00
15811	10.13	5.40	33.12	8.89	35.68	6.78	32.00
15782	9.80	5.24	34.12	8.20	34.88	7.76	32.00
	10.45	5.39	32.69	8.51	35.82	7.14	32.00
	----	----	29.1	4.8	27.9	6.4	
15608	9.95	6.35	15.75	7.67	55.59	4.69	24.00
15609	10.13	5.47	14.06	8.46	57.30	4.58	20.00
15746	9.93	7.36	14.87	9.28	53.85	4.71	20.00
15751	10.20	8.95	15.37	8.79	52.62	4.07	20.00
15803	10.06	6.48	15.81	8.59	54.44	4.62	22.00
15846	11.34	6.46	14.25	10.26	53.25	4.44	24.00
15762	11.15	7.05	15.12	8.68	53.11	4.89	20.00
15687	11.48	5.79	14.50	8.52	55.63	4.08	22.00
15604	9.95	6.67	17.00	8.67	52.76	4.95	19.00
	10.47	6.73	15.19	8.77	54.28	4.56	21.22
	----	----	11.7	1.8	37.4	3.0	
15750	9.55	7.25	14.75	10.43	53.32	4.70	21.00
15662	11.49	5.92	13.00	10.38	54.95	4.26	22.00
15798	10.27	6.62	14.25	11.79	52.19	4.88	24.00

TABLE IV.—ANALYSES OF COMMERCIAL FEEDS—*Continued.*

Station No.	BRAND.	RETAIL DEALER.
<i>WHEAT PRODUCTS—Continued.</i>		
<i>Bran from Spring Wheat.</i>		
15613	Badger. Berger-Crittenden Milling Co., Milwaukee	<i>Branford</i> : S. V. Osborn
15733	Niagara. Cataract City Milling Co., Niagara Falls, N. Y.	<i>Willimantic</i> : H. A. Bugbee
15790	Cataract City Mill Co., Niagara Falls, N. Y.	<i>Hamden</i> : I. W. Beers
15642	◇ Ogilvie's. C. M. Cox, Boston, Mass.	<i>New Britain</i> : M. D. Stanley
15739	Fulton Milling Co., Sioux Falls, S. Dak.	<i>Putnam</i> : F. M. Cole & Co.
15694	Clover Leaf. The Gardner Mill, Seymour Carter, Hastings, Minn.	<i>Manchester</i> : Manchester Elevator Co.
15723	Fancy Flaky. Hubbard Milling Co., Mankato, Minn.	<i>Colchester</i> : Colchester Grain & Coal Co.
15636	Duluth Imperial. Imperial Mill Co., Duluth, Minn.	<i>Meriden</i> : A. H. Cashen
15629	L—K.	<i>Meriden</i> : Meriden Grain and Feed Co.
15809	Ben Hur. Royal Mill Co., Minneapolis.	<i>Stamford</i> : Scofield & Miller ..
15653	Washburn, Crosby Co.'s, Washburn Mills	<i>Southington</i> : Southington Lumber and Feed Co.
15706	" " "	<i>Suffield</i> : Spencer Bros.
15742	Broad Flaky. Wells Flour Mill. Co., Wells, Minn.	<i>Putnam</i> : F. M. Cole & Co.
		Average of these 16 analyses ..
		Average digestible
<i>Middlings, Winter Wheat.</i>		
15760	Trojan. The Allen & Wheeler Co., Troy, Ohio	<i>Jewett City</i> : J. E. Leonard & Son ..
15789	Cataract City Mill. Co., Niagara Falls, N. Y.	<i>Hamden</i> : I. W. Beers
15664	M. Hecker-Jones-Jewell Milling Co., New York	<i>Plainville</i> : G. W. Eaton
15743	Fancy. Williams Bros. Co., Kent, Ohio	<i>Putnam</i> : Bosworth Bros.
		Average of these 4 analyses ..
		Average digestible
<i>Middlings, Spring Wheat.</i>		
15749	Standard. John Alden Co., Minneapolis, Minn.	<i>Danielson</i> : Quinebaug Store
15799	Bay State Milling Co., Winona, Minn.	<i>Ansonia</i> : Ansonia Flour and Grain Co.
15744	Standard. L. Christian & Co., Minneapolis, Minn.	<i>Putnam</i> : Bosworth Bros.
15761	Snowball. Gardner Mills, Seymour Carter, Hastings, Minn.	<i>Jewett City</i> : J. E. Leonard & Son ..
15805	Gooding-Coxe Co., Minneapolis, Minn.	<i>Guilford</i> : Morse & Landon
15659	Commander. Gregory Cook Co., Duluth, Minn.	<i>Plainville</i> : F. B. Newton
15619	W. J. Jennison, Minneapolis	<i>East Haven</i> : F. A. Forbes
15617	The Northwestern Consolidated, Minneapolis	<i>Branford</i> : S. V. Osborn
15667	B. Pillsbury's, Minneapolis, Minn.	<i>Bristol</i> : W. O. Goodsell
15712	XX Daisy. Pillsbury's, Minneapolis, Minn.	<i>Thompsonville</i> : H. K. Brainard ..
15810	Ben Hur. Royal Mill Co., Minneapolis	<i>Stamford</i> : Scofield & Miller
15695	Star and Crescent Mill. Co., Chicago, Ill.	<i>Rockville</i> : Edward White
15644	Standard. Washburn, Crosby Co.'s, Washburn Mills	<i>New Britain</i> : C. W. Lines Co
15728	" " "	<i>East Hampton</i> : R. H. Hall
15754	George Urban Milling Co., Buffalo, N. Y.	<i>Plainfield</i> : J. P. Kingsley & Son ..
15741	No. 1 Extra. Wells Flour Mill. Co., Wells, Minn.	<i>Putnam</i> : F. M. Cole & Co.
		Average of these 16 analyses ..
		Average digestible

SAMPLED IN 1905.

Station No.	ANALYSES.						Price per ton.
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Fat. (Ether Extract.)	
15613	11.18	5.56	13.44	9.54	57.03	4.25	\$22.00
15733	10.59	5.83	13.75	9.18	55.67	4.98	20.00
15790	10.50	7.15	15.56	10.40	51.09	5.30	19.00
15642	11.22	6.12	13.44	9.39	54.68	5.15	23.00
15739	10.78	6.91	15.12	10.97	51.24	4.98	19.00
15694	11.23	5.83	13.37	11.26	53.78	4.53	22.00
15723	11.43	7.04	13.50	10.83	52.66	4.54	19.00
15636	11.48	5.32	14.87	8.08	55.75	4.50	21.00
15629	10.81	5.65	13.12	10.82	55.36	4.24	22.00
15809	10.76	6.56	13.87	11.68	52.74	4.39	20.00
15653	10.63	6.47	14.19	11.07	52.99	4.65	22.00
15706	12.14	5.86	13.62	11.30	52.35	4.73	23.00
15742	10.35	6.92	15.12	11.52	50.96	5.13	19.00
	10.90	6.31	14.06	10.54	53.49	4.70	21.13
	----	----	10.8	2.2	36.9	3.1	
15760	10.78	4.38	16.50	4.99	58.95	4.40	25.00
15789	11.16	3.87	14.87	5.92	59.96	4.22	21.50
15664	10.88	4.60	16.37	7.65	56.08	4.42	25.00
15743	11.05	4.27	18.00	3.85	57.80	5.03	21.00
	10.97	4.28	16.44	5.60	58.19	4.52	23.12
	----	----	12.7	1.7	45.4	4.0	
15749	11.11	5.23	17.87	6.82	53.83	5.14	21.00
15799	11.09	5.39	17.50	7.07	53.05	5.90	23.00
15744	11.28	6.00	16.29	6.41	55.06	5.06	20.00
15761	10.84	4.36	16.50	6.48	57.04	4.78	25.00
15805	12.08	3.74	16.00	5.70	57.80	4.68	24.00
15659	12.12	3.61	15.75	4.76	59.19	4.57	25.00
15619	11.64	3.20	16.12	4.65	60.46	3.93	22.00
15617	11.29	4.75	14.37	8.18	57.13	4.28	25.00
15667	11.68	5.65	16.12	8.38	53.29	4.88	22.00
15712	12.24	4.12	18.12	2.99	58.14	4.39	27.00
15810	11.69	4.82	18.81	4.77	54.83	5.08	25.00
15695	11.65	3.80	15.31	5.29	59.74	4.21	24.00
15644	11.74	4.60	16.75	5.53	56.63	4.75	23.00
15728	11.13	5.76	17.25	8.14	52.51	5.21	23.00
15754	11.39	4.95	17.81	6.76	53.98	5.11	21.00
15741	11.42	4.77	18.00	4.57	55.70	5.54	23.00
	11.34	4.67	16.78	6.03	56.34	4.84	23.31
	----	----	12.9	1.8	43.9	4.3	

SAMPLED IN 1905.

Station No.	ANALYSES.						Price per ton.
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Fat. (Ether Extract.)	
15693	11.49	5.87	17.00	7.19	54.00	4.45	\$22.00
15759	10.30	5.55	15.62	6.77	57.30	4.46	25.00
15820	11.23	5.81	16.12	7.49	54.82	4.53	22.00
15785	10.40	5.42	15.50	8.08	56.22	4.38	22.00
15791	10.61	5.07	16.19	6.47	57.07	4.59	21.00
15708	12.12	5.87	16.12	8.02	53.31	4.56	24.00
15794	11.71	6.12	16.25	7.88	53.30	4.74	20.00
15672	10.41	5.95	16.50	9.19	53.45	4.50	24.00
15786	10.57	5.00	15.25	8.46	56.03	4.69	23.00
15654	10.73	6.32	17.50	8.26	52.71	4.48	24.00
15660	11.66	6.33	15.94	7.45	54.03	4.59	24.00
15722	12.27	6.77	16.37	7.80	51.63	5.16	22.00
15643	11.32	6.37	16.37	6.95	54.60	4.39	24.00
15657	11.71	5.70	16.25	6.33	55.80	4.21	24.00
15752	10.03	6.27	16.75	7.21	55.38	4.36	22.00
15612	11.55	5.96	15.62	8.16	54.18	4.53	21.00
15725	11.52	5.06	14.62	8.74	56.00	4.06	22.00
15623	10.73	6.23	16.50	7.50	54.48	4.56	21.00
15736	10.45	4.83	15.50	6.04	59.95	4.23	22.00
15833	10.11	6.35	17.00	7.49	54.34	4.71	24.00
15704	10.35	4.75	16.00	7.09	57.40	4.41	24.00
	11.01	5.79	15.66	7.55	55.49	4.50	22.70
	----	----	12.1	2.0	41.1	3.5	
15691	11.19	4.85	14.12	9.26	56.28	4.30	24.00
15600	10.77	4.51	14.00	7.03	59.61	4.08	20.00
15649	11.40	5.02	14.50	8.52	56.23	4.33	22.00
15658	11.28	5.32	14.25	8.35	56.14	4.66	24.00
15690	11.46	4.76	14.25	8.75	55.96	4.82	22.00
15707	11.60	4.26	14.87	7.74	57.12	4.41	25.00
15589	11.25	5.12	13.75	7.29	58.14	4.45	21.00
15641	11.05	4.82	16.44	6.00	57.42	4.27	25.00
15630	10.91	4.44	14.25	7.26	59.50	3.64	27.00
15596	12.30	5.63	15.62	7.26	54.38	4.81	22.00
15731	11.00	3.98	14.56	6.81	58.87	4.78	23.00
15697	11.10	4.94	14.62	7.91	56.90	4.53	23.00
15668	10.53	4.90	14.69	8.54	56.72	4.62	24.00
15627	10.25	3.94	15.12	5.86	60.91	3.92	21.00
15609	10.79	4.94	15.25	7.18	56.82	5.11	24.00
15730	11.94	4.97	16.12	7.08	54.98	4.91	23.00

SAMPLED IN 1905.

Station No.	ANALYSES.						Price per ton.
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Fat. (Ether Extract.)	
15622	7.47	4.52	14.62	6.90	62.61	3.88	\$21.00
15674	11.32	5.55	16.87	8.54	53.20	4.52	24.00
15806	10.50	5.02	16.25	7.58	55.77	4.88	22.00
15814	11.41	4.82	16.37	6.61	55.96	4.83	24.00
15621	10.22	4.40	15.25	6.35	60.35	3.43	21.00
15740	10.80	6.15	16.25	8.86	52.56	5.38	21.00
	10.88	4.86	15.09	7.53	57.15	4.49	22.86
	----	----	11.6	2.0	42.3	3.5	
15652	12.57	1.27	8.62	1.58	72.23	3.73	25.00
15781	10.67	2.31	10.26	3.22	65.57	7.98	28.00
15611	11.99	1.39	9.25	1.59	72.32	3.46	25.50
15595	13.24	1.20	8.32	1.63	72.38	3.23	24.00
15766	12.64	1.36	8.87	1.57	71.63	3.93	26.00
15770	11.82	1.26	8.62	1.51	74.36	2.43	26.00
15603	12.17	1.06	8.81	1.98	72.86	3.12	23.00
	12.14	1.40	8.96	1.87	71.65	3.98	25.35
	----	----	6.3	----	67.4	3.6	
15646	8.35	1.44	31.87	2.27	50.40	5.67	34.00
15681	11.06	2.31	29.37	2.72	49.54	5.00	31.00
15767	7.95	1.60	32.87	2.30	49.57	5.71	32.00
15830	9.16	1.95	33.62	1.80	47.80	5.67	30.00
	9.13	1.82	31.93	2.27	49.34	5.51	31.75
	----	----	28.4	----	45.9	5.1	
15684	8.06	1.39	33.00	2.07	50.94	4.54	32.00
15838	9.97	2.07	32.37	2.01	48.50	5.08	34.00
	9.01	1.73	32.68	2.04	49.73	4.81	33.00
	----	----	27.4	----	43.8	4.7	
15756	9.79	2.62	24.00	7.31	51.53	4.75	27.00
	----	----	20.4	5.5	45.9	3.9	
15632	9.73	3.17	25.44	7.14	50.97	3.55	27.00
15780	10.44	2.51	22.87	7.15	53.02	4.01	27.00
15823	8.94	2.94	24.50	7.87	52.21	3.54	27.00
15844	9.54	1.51	24.12	7.17	54.91	2.75	27.00
	9.66	2.53	24.23	7.33	52.79	3.46	27.00
	---	----	20.6	5.6	47.0	2.9	
15700	7.37	3.57	28.75	10.60	37.90	11.81	27.00
15771	8.03	3.42	28.75	10.67	37.35	11.78	29.00
	7.70	3.49	28.75	10.63	37.64	11.79	28.00
	----	----	21.3	----	30.9	11.2	
15772	8.50	0.93	18.75	7.56	58.83	5.43	29.00
	----	----	15.9	5.7	52.4	4.5	

SAMPLED IN 1905.

Station No.	ANALYSES.						Price per ton.
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Fat. (Ether Extract.)	
15738	8.05	1.02	20.37	6.22	59.18	4.26	\$27.00
15842	8.80	1.10	19.00	6.51	59.05	5.54	27.00
	8.87	1.06	19.68	6.36	59.13	4.90	27.00
	----	----	16.7	4.8	52.6	4.1	
15625	9.45	1.85	25.75	5.91	51.89	5.15	25.00
15734	9.94	3.15	26.25	7.04	50.69	2.93	26.00
15779	7.23	0.80	24.37	7.63	56.65	3.32	26.00
15645	10.78	2.31	24.94	6.52	52.01	3.44	27.00
15676	9.84	1.70	24.00	6.95	53.74	3.77	26.00
15698	10.26	2.02	23.75	7.03	53.68	3.26	27.00
15807	7.23	2.39	25.62	6.71	54.85	3.20	27.00
15813	8.25	1.01	23.75	6.74	57.36	2.89	27.00
15827	8.98	0.94	21.37	7.81	57.92	2.98	27.00
15831	10.27	2.36	24.12	7.06	52.93	3.26	27.00
15914	6.89	1.01	24.25	7.63	57.10	3.12	27.00
	9.01	1.78	24.38	7.00	54.44	3.39	26.55
	----	----	20.7	5.3	48.5	2.8	
15605	8.03	1.57	25.19	7.36	54.85	3.00	26.00
15615	8.02	1.56	23.75	7.89	55.65	3.13	26.00
15835	7.77	1.79	23.87	8.03	55.65	2.89	27.00
15915	8.15	1.90	25.00	7.39	53.91	3.65	28.00
	7.99	1.70	24.20	7.67	55.07	3.17	26.75
	----	----	20.6	5.8	49.0	2.6	
15692	11.18	1.05	22.00	7.07	56.05	2.65	28.00
	----	----	18.7	5.4	49.9	2.2	
15620	8.91	3.54	26.94	7.23	50.38	3.00	25.00
15628	9.33	3.45	26.44	7.58	50.00	3.20	26.00
15661	13.29	2.92	27.50	7.37	46.57	2.35	26.00
15711	8.87	2.75	27.00	7.76	50.11	3.51	27.00
15718	8.31	3.51	26.44	7.10	51.67	2.97	26.00
15783	8.63	3.14	26.37	7.49	50.58	3.79	24.00
15787	7.63	3.07	29.25	7.47	50.01	2.57	25.00
15793	8.51	3.15	26.87	7.86	50.69	2.92	25.00
15815	9.03	3.09	26.87	7.40	49.92	3.69	27.00
15834	9.46	2.65	26.25	7.09	51.76	2.79	27.00
	9.19	3.13	26.99	7.44	50.17	3.08	25.80
	----	----	22.9	5.7	44.7	2.6	
15640	8.32	1.05	19.25	5.34	62.23	3.81	26.00
15670	10.87	1.08	20.37	4.36	59.39	3.93	27.00
15802	9.78	0.92	16.25	7.46	60.24	5.35	26.00

TABLE IV.—ANALYSES OF COMMERCIAL FEEDS—*Continued.*

Station No.	BRAND.	RETAIL DEALER.
MAIZE PRODUCTS—<i>Concluded.</i> <i>Gluten Feed.</i>		
15588	Bay State. J. E. Soper & Co., Boston	New Haven: R. G. Davis Average of these 4 analyses... Average digestible
15614	Warner's Gluten Feed. Warner Sugar Refining Co., Waukegan, Ill.	Branford: S. V. Osborn
15655	" " " "	Southington: Southington Lum- ber and Feed Co.
15720	" " " "	Middlefield: A. E. Miller
15804	" " " "	Guilford: Morse & Landon .. Average of these 4 analyses Average digestible
<i>Hominy Feed.</i>		
15701	M. F. Berringer, Philadelphia, Pa.	Suffield: Arthur Sikes
15634	Hominy Feed. Buffalo Cereal Co., Buffalo, N. Y.	Meriden: A. H. Cashen
15755	" " " " " "	Plainfield: Waldo Tillinghast ..
15764	" " " " " "	Norwich: Norwich Grain Co.
15616	Chapin & Co., Boston	Branford: S. V. Osborn
15656	Green Diamond. Chapin & Co., Boston	Southington: Southington Lum- ber and Feed Co.
15710	" " " " " "	Thompsonville: H. K. Brainard ..
15727	The Coles Co., Middletown	East Hampton: R. H. Hall
15618	Paragon. Chas M. Cox Co., Boston	East Haven: F. A. Forbes
15624	" " " " " "	Wallingford: E. E. Hall
15663	Wirthmore. " " " " " "	Plainville: G. W. Eaton
15788	" " " " " "	North Haven: Co-operative Feed Co.
15800	Monarch Chop. Husted Mill & Elev. Co. Buffalo, N. Y.	Shelton: Taylor & Morse
15822	Husted Mill and Elevator Co., Buffalo, N. Y.	Newtown: Taylor & Hubbell ..
15774	The Hunter Bros. Mill. Co., St. Louis, Mo.	Norwich: Chas. Slosberg
15753	Hollister, Chase & Co., New York	Plainfield: J. P. Kingsley & Son ..
15776	Peerless. F. L. Kidder & Co., Paris, Ill.	Mystic: J. L. Manning
15777	Meech & Stoddard, Middletown, Conn.	Groton: Groton Grain Co.
15671	Choice Steam Cooked Hominy Feed. Miner, Hil- lard Mill. Co., Wilkesbarre, Pa.	Bristol: G. W. Eaton
15795	Steam Cooked Hominy Feed. Miner-Hillard Mill. Co., Wilkesbarre, Pa.	Ansonia: Ansonia Flour and Grain Co.
15590	Wm. M. Payne & Son, New York	New Haven: R. G. Davis
15784	" " " " " "	Clintonville: S. A. Smith
15792	" " " " " "	Hamden: I. W. Beers
15724	Simpson, Hendee & Co., New York	Colchester: Colchester Grain and Coal Co.
15763	Suffern, Hunt & Co., Decatur, Ill.	Yantic: A. R. Manning
15757	Star Feed. The Toledo Elev. Co., Toledo, Ohio ..	Jewett City: J. E. Leonard & Son ..
15821	" " " " " "	Bethel: Johnson & Morrison ..
15837	The J. S. Wolfe Co., Pittsfield, Mass.	Winsted: Balch & Platt
15682	No Brand	Hartford: Smith, Northam & Co.
15721	.....	Middlefield: A. E. Miller
		Average of these 30 analyses... Average digestible

SAMPLED IN 1905.

Station No.	ANALYSES.						Price per ton.
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Fat. (Ether Extract.)	
15588	10.19 9.79 ----	0.97 1.00 ----	18.31 18.54 15.8	4.18 5.33 4.1	62.94 61.22 54.5	3.41 4.12 3.4	\$24.00 25.75
15614	9.40	1.34	20.62	7.53	58.33	2.78	26.00
15655	8.42	1.97	24.06	6.60	54.21	4.74	26.00
15720	9.77	1.74	22.62	7.42	54.81	3.64	25.00
15804	8.89 9.12 ----	1.55 1.65 ----	20.62 21.08 18.8	7.27 7.20 5.5	57.95 56.32 50.1	3.76 3.73 3.1	26.00 25.75
15701	9.47	3.02	10.75	5.20	62.15	9.41	24.00
15034	9.79	2.61	10.50	4.27	64.55	8.28	25.00
15755	10.43	2.82	10.94	4.18	62.47	9.16	23.00
15764	10.30	2.61	10.62	3.89	64.94	7.64	25.00
15616	11.40	2.50	10.37	4.09	64.55	7.09	24.00
15656	9.84	2.50	9.75	5.45	65.68	6.78	25.00
15710	10.83	2.96	10.69	5.05	61.77	8.70	24.00
15727	9.19	2.74	10.37	4.17	64.84	8.69	24.00
15618	10.54	3.22	11.37	4.59	61.26	9.02	23.00
15624	7.34	2.92	10.12	4.30	66.25	9.07	23.00
15663	10.09	3.16	10.75	4.27	60.91	10.82	25.00
15788	9.52	2.76	10.31	4.85	63.84	8.72	23.00
15800	10.67	2.81	8.12	9.68	64.58	4.14	22.50
15822	10.03	2.47	9.50	6.58	64.35	7.07	25.00
15774	8.71	3.30	10.87	5.07	62.25	9.80	24.00
15753	8.53	2.72	10.25	4.43	65.71	8.36	22.50
15776	9.83	2.31	10.00	5.50	65.32	7.04	24.00
15777	8.95	3.35	9.50	8.68	62.74	6.78	23.00
15671	9.50	2.66	10.50	4.48	64.39	8.47	25.00
15795	10.34	2.87	10.62	4.74	62.46	8.97	23.00
15590	9.89	2.77	10.62	2.62	65.90	8.20	23.00
15784	9.66	2.53	10.25	3.96	65.45	8.15	24.00
15792	9.41	2.67	10.62	4.56	64.61	8.13	23.00
15724	9.96	2.60	10.75	3.55	66.04	7.10	25.00
15763	9.38	2.87	9.75	3.87	65.33	8.80	24.00
15757	8.02	3.15	9.37	9.89	62.85	6.72	24.00
15821	8.47	2.83	9.00	9.89	63.38	6.43	24.00
15837	8.69	2.72	9.87	3.66	67.11	7.95	24.00
15682	8.63	2.76	10.37	3.97	65.86	8.41	26.00
15721	9.74 9.57 ----	2.91 2.80 ----	9.50 10.20 7.1	6.88 5.21 ----	63.92 64.19 60.3	7.05 8.03 7.3	23.00 23.88

SAMPLED IN 1905.

Station No.	ANALYSES.						Price per ton.
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Fat. (Ether Extract.)	
15602	11.65	3.52	16.19	3.89	61.52	3.23	\$22.50
15699	12.34	3.61	15.25	4.06	61.77	2.97	24.00
15797	11.89	3.93	16.25	3.83	61.09	3.01	28.00
15840	11.76	4.12	16.50	4.32	59.83	3.47	25.00
15715	12.36	4.14	15.87	4.14	60.22	3.27	25.00
15597	13.46	3.39	15.50	3.20	61.64	2.81	20.00
15689	12.42	3.50	15.25	3.44	62.48	2.91	23.00
	12.27	3.74	15.83	3.84	61.23	3.09	23.93
	----	----	13.3	----	56.3	2.0	
15593	9.56	5.30	23.75	11.01	49.14	1.24	20.00
15825	8.79	6.65	27.62	10.42	43.97	2.55	21.00
	9.15	5.97	25.68	10.71	46.60	1.89	20.50
	----	----	20.5	3.6	32.2	1.9	
15673	8.17	2.15	31.25	12.56	32.90	12.97	28.00
15686	7.36	2.00	32.81	11.48	31.92	14.43	26.00
15843	7.09	1.89	28.62	13.66	36.08	12.66	28.00
	7.54	2.01	30.89	12.56	33.65	13.35	27.33
	----	----	22.9	----	27.6	12.7	
15748	11.93	5.75	30.87	8.62	34.35	8.48	22.00
15816	10.01	12.28	20.25	18.56	36.71	2.19	38.00
15599	10.37	3.73	8.12	10.06	63.83	3.89	19.00
15717	10.72	3.95	8.12	10.57	62.66	3.98	24.00
	10.54	3.84	8.12	10.31	63.26	3.93	21.50
	----	----	5.8	4.9	52.5	3.4	
15633	10.01	3.72	8.00	12.24	62.25	3.78	23.00
15606	9.46	4.76	8.87	10.29	61.57	5.05	21.00
15832	11.93	2.05	9.75	3.87	68.05	4.35	26.00
15665	11.19	2.47	8.00	6.86	67.56	3.92	25.00
15775	9.01	3.07	9.37	7.69	64.73	6.13	26.00
	10.32	3.21	8.79	8.19	64.85	4.64	24.20
	----	----	6.2	3.9	53.8	4.0	
15679	11.44	3.48	13.12	5.59	59.99	6.38	26.00
15826	9.75	5.85	11.56	14.08	55.56	3.20	20.00
15696	11.02	4.65	10.94	15.09	55.22	3.08	21.00

TABLE IV.—ANALYSES OF COMMERCIAL FEEDS—*Continued.*

Station No.	BRAND.	RETAIL DEALER.
CORN-COB AND WHEAT FEEDS— <i>Concluded.</i>		
15732	Dairy Mixed Feed. Jennings & Fulton, Boston..	Stafford Springs: Geo. L. Dennis
15651	" " J. & F.	Plantsville: Atwater Mills.....
15598	Indiana " Indiana Milling Co., Terre Haute, Ind.	New Haven: J. T. Benham Est.
15745	Jersey " " " " " " " " " " " "	Danielson: Waldo Bros.
15747	Blue Grass Mixed Feed	" Young Bros. Co.
		Average of these 7 analyses...
CORN, OATS AND BARLEY.		
15801	Corn, Oats and Barley Feed. Husted Mill and Elev. Co., Buffalo, N. Y.	Shelton: Taylor & Morse
15601	Schumacher's Stock Feed. American Cereal Co.	New Haven: J. T. Benham Est.
PROPRIETARY HORSE FEEDS.		
15714	Sucrene Horse Feed. Am'n Mill. Co., Chicago..	Middletown: Meech & Stoddard
15796	" " " " " " " " " " " "	Ansonia: Ansonia Flour and Grain Co.
		Average of these 2 analyses...
15635	Horse Feed. Buffalo Cereal Co., Buffalo, N. Y.	Meriden: A. H. Cashen.....
15610	H. O. Co.'s Horse Feed, Buffalo, N. Y.	New Haven: Abner Hendee...
PROPRIETARY DAIRY AND STOCK FEEDS.		
15685	Quaker Dairy Feed. American Cereal Co.	Hartford: Smith, Northam & Co.
15648	Sucrene Dairy Feed. American Milling Co., Chicago, Ill.	New Britain: C. W. Lines Co.
15713	" " " " " " " " " " " "	Middletown: Meech & Stoddard
15719	" " " " " " " " " " " "	" " " " " " " " " " " "
		Average of these 3 analyses...
15591	Dairy Feed XXXX Grains. { The J. W. Biles Co.,	New Haven: R. G. Davis
15769	" " " { Cincinnati, Ohio..	Yantic: A. R. Manning.....
		Average of these 2 analyses...
		Average digestible
15592	Dairy Feed, Union Grains. { The J. W. Biles Co.,	New Haven: R. G. Davis ...
15677	" " " { Cincinnati, Ohio..	Hartford: Daniels Mill Co. ...
15729	" " " " " " " " " " " "	East Hampton: R. H. Hall ...
		Average of these 3 analyses...
15666	Creamery Feed. Buffalo Cereal Co., Buffalo, N. Y.	Bristol: W. O. Goodsell
15778	XXX Stock Feed. " " " " " " " " " " " "	New London: The Arnold Rudd Co.
15705	Durham Stock Feed. The Great Western Cereal Co., Chicago	Suffield: Arthur Sikes.....
		Digestible
15828	Excelsior Stock Feed. " " " " " " " " " " " "	Danbury: F. C. Benjamin & Co.
		Digestible
15819	Blatchford's Calf Meal. Waukegan, Ill.	Norwich: Brower & Malone ...
15678	Stock Feed. Daniel's Mill Co., Hartford	Hartford: Daniels Mill Co. ...
		Digestible

SAMPLED IN 1905.

Station No.	ANALYSES.						Price per ton.
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Fat. (Ether Extract.)	
15732	10.28	4.59	10.62	14.38	57.24	2.89	\$21.00
15651	10.00	5.94	11.94	13.93	54.96	3.23	22.00
15598	9.98	4.65	10.62	16.71	55.21	2.83	20.00
15745	10.27	4.68	11.87	13.47	57.19	2.52	22.00
15747	9.40	4.21	10.75	14.98	57.57	3.09	19.00
	10.10	4.94	11.19	14.66	56.13	2.98	20.71
15801	11.27	3.19	9.06	9.76	62.92	3.80	26.00
15601	9.25	4.23	11.12	10.22	60.42	4.76	24.00
15714	12.75	6.76	11.87	7.45	58.69	2.48	27.00
15796	11.62	6.68	12.62	8.44	58.00	2.64	27.00
	12.19	6.72	12.24	7.96	58.33	2.56	27.00
15635	9.84	3.68	11.50	10.31	59.59	5.08	26.00
15610	8.89	3.75	12.87	9.44	59.82	5.23	27.00
15685	9.33	5.32	11.75	17.59	52.96	3.05	21.00
15648	10.28	6.17	16.12	9.57	53.37	4.49	26.00
15713	12.71	6.15	13.00	6.76	59.09	2.29	26.00
15719	11.21	6.35	15.94	9.54	52.53	4.43	26.00
	11.40	6.22	15.02	8.62	55.00	3.74	26.00
15591	7.84	2.24	30.31	11.30	36.97	11.34	27.00
15769	7.48	2.24	32.00	12.39	34.29	11.60	27.00
	7.66	2.24	31.16	11.85	35.62	11.47	27.00
	----	----	23.1	----	29.2	10.9	
15592	8.37	6.96	23.44	7.92	46.02	7.29	27.00
15677	9.17	7.63	23.37	8.83	43.78	7.22	
15729	9.25	5.52	22.00	9.64	46.44	7.15	29.00
	8.93	6.70	22.94	8.79	45.43	7.21	28.00
15666	8.94	4.24	19.62	11.84	50.71	4.65	26.00
15778	9.20	3.87	10.12	11.81	59.57	5.43	24.00
15705	10.42	4.77	8.31	12.72	57.78	6.00	24.00
	----	----	5.9	6.1	47.8	5.2	
15828	8.57	5.87	8.62	12.23	58.42	6.29	22.00
	----	----	6.1	5.9	48.5	5.5	
15819	11.44	5.46	26.25	3.69	48.33	4.83	60.00
15678	12.47	2.09	9.87	4.79	67.25	3.53	26.00
	----	----	7.0	2.3	55.8	3.1	

TABLE IV.—ANALYSES OF COMMERCIAL FEEDS—*Concluded.*

Station No.	BRAND.	RETAIL DEALER.
	PROPRIETARY DAIRY AND STOCK FEEDS—<i>Concluded.</i>	
15845	Stock Feed. The Mill Dickinson's.....	Waterbury: D. L. Dickinson.. Digestible
15758	Haskell's Stock Feed. W. H. Haskell & Co., Toledo, Ohio	Jewett City: J. E. Leonard & Son
		Digestible
15650	New England Stock Feed. H. O. Co. Mills, Buf- falo, N. Y.	New Britain: C. W. Lines Co.. Digestible
15808	H. O. Dairy Feed. Buffalo, N. Y.....	Stamford: Scofield & Miller ... Digestible
15768	Clark Bros. & Co. Pure Empire State Dairy Feed. J. D. Page & Co., Syracuse, N. Y.....	Yantic: A. R. Manning
		Digestible
15639	Protena Dairy Feed. Purina Mills, St. Louis, Mo.	New Britain: M. D. Stanley ..
15702	" " " " " " " "	Suffield: Arthur Sikes
		Average of these 2 analyses ...
15824	Lenox Stock Feed. The Strong, Lefferts Co., Springfield, Mass.....	Danbury: F. C. Benjamin & Co.. Digestible
15594	Hammond Dairy Feed. Western Grain Products Co., Milwaukee.....	New Haven: R. G. Davis ...
	PROPRIETARY POULTRY FEEDS.	
15812	Poultry Feed. American Cereal Co.....	New Canaan: C. H. Fairty....
15637	" " Buffalo Cereal Co., Buffalo, N. Y.	Meriden: A. H. Cashen
15607	H. O. Co.'s Poultry Feed. Buffalo, N. Y.	New Haven: Abner Hendee....
15817	Purina Chick Feed. Purina Mills, St. Louis, Mo.	Norwalk: The Holmes, Keeler & Selleck Co.
15818	Daniels Mill Co., Hartford, Conn.....	Norwalk: The Holmes, Keeler & Selleck Co.
15839	Laying Feed. Cyphers Incubator Co., Buffalo....	Torrington: F. U. Wadhams ..
	ANIMAL MEAL AND BONE FOR POULTRY.	
15841	Bone and Meat Meal. Rogers Mfg. Co., Rockfall	Torrington: F. U. Wadhams ..
15703	Frisbie's Beef Scrap. The L. T. Frisbie Co., Hartford ...	Suffield: Arthur Sikes
15647	Swift's Lowell Bone and Meat Meal. Swift's Lowell Fert. Co., Boston, Mass.	New Britain: C. W. Lines Co..

SAMPLED IN 1905.

Station No.	ANALYSES.						Price per ton.
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, gum, etc.)	Fat. (Ether Extract.)	
15845	10.48 ----	3.25 ----	8.25 5.9	11.09 5.3	63.12 52.4	3.81 3.3	\$20.00
15758	7.46 ----	3.62 ----	9.00 6.3	8.83 4.2	64.27 53.3	6.82 5.9	25.00
15650	9.81 ----	3.19 ----	9.12 6.5	10.44 5.0	62.97 52.3	4.47 3.9	24.00
15808	8.65 ----	3.94 ----	20.31 15.8	12.27 5.0	50.03 35.0	4.80 4.1	29.00
15768	7.35 ----	2.21 ----	29.50 21.8	12.92 ----	36.41 29.9	11.61 11.0	27.00
15639	8.81	7.20	18.12	17.51	44.45	3.90	27.00
15702	9.35 9.08	7.99 7.60	20.12 19.12	17.61 17.56	41.47 42.96	3.46 3.68	25.00 26.00
15824	11.72 ----	3.11 ----	8.50 6.0	9.14 4.4	64.59 53.60	2.94 2.6	25.00
15594	10.67	7.12	14.62	9.47	54.46	3.66	25.00
15812	11.86	3.36	13.12	5.39	61.24	5.03	32.00
15637	10.22	3.15	16.25	4.11	60.67	5.60	34.00
15607	10.50	3.18	17.25	4.45	58.50	6.02	35.00
15817	11.19	3.31	12.37	4.41	63.41	5.31	44.00
15818	10.80	13.97	9.62	3.51	58.78	3.32	49.00
15839	12.59	3.20	14.06	4.11	62.32	3.72	40.00
15841	7.11	38.76	41.37	----	----	6.05	44.00
15703	9.79	27.31	46.56	----	----	13.33	45.00
15647	6.80	31.68	45.19	----	----	10.34	48.00

SUMMARY.

The examinations of these feeds show that in many cases the dealers do not give the guaranties, as required by law. When given, they are too often misleading, being much higher than the composition of the goods warrants. This is especially noticeable in the gluten meals and gluten feeds.

The mixtures of wheat feed and corn-cobs, formerly sold, illegally, as "wheat feed," are now sold under distinctive names and with a guaranty; thus complying with the law.

There are still on the market a large number of low grade mixed feeds, of very moderate feeding value, but sold for only a few dollars per ton less than the standard high grade feeds.

PART IV.

FIFTH REPORT

OF THE

STATE ENTOMOLOGIST OF CONNECTICUT

To the Director and Board of Control of the Connecticut Agricultural Experiment Station:

Section 4387 of the General Statutes requires that the State Entomologist publish each year an account of the work and expenditures of his office. I transmit herewith my fifth annual report, and in its preparation have followed the custom of previous years, the period covered by the work being for the calendar year of 1905, except that the financial report covers the year ending September 30, 1905, and therefore corresponds with the State fiscal year.

Respectfully submitted,

W. E. BRITTON,
State Entomologist.

REPORT OF THE RECEIPTS AND EXPENDITURES OF THE STATE ENTOMOLOGIST FROM OCTOBER 1ST, 1904, TO SEPTEMBER 30TH, 1905.

Receipts.

From E. H. Jenkins, Treasurer	\$3,132.77
G. P. Clinton, for stamps	.59
T. Campbell, for mileage	1.44
Prof. S. A. Forbes, electrotypes	1.08
	\$3,135.88

Expenditures.

Field, office and laboratory assistance	\$1,371.47
Printing and illustrations	601.07
Postage	14.86
Stationery	9.42

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Telephone and telegraph	\$ 1.90	
Express, freight and cartage	31.25	
Library	120.95	
Laboratory apparatus and supplies	327.71	
Spraying apparatus and supplies	54.99	
Office supplies	137.94	
Traveling expenses	251.91	
	\$2,923.47	
Balance, cash on hand	212.41	
		\$3,135.88

Memorandum—This account of the State Entomologist has been duly audited by the State Auditors of Public Accounts.

ORGANIZATION, EQUIPMENT, ETC.

Mr. B. H. Walden has continued as general assistant during the year. Most of the curatorial work of the collection has been done by him, as has also most of the photographic work. He has assisted in the work of spraying and other investigation and in the preparation of this report. Mr. Henry L. Viereck assisted in field and laboratory work from June 15 to September 15. A stenographer has been employed for half of each day to assist in the correspondence, cataloguing of specimens, and the preparation of manuscript. This work was done by Miss Anna Davis Clark during January, and by Miss Elizabeth B. Whittlesey for the remaining portion of the year.

The insect collection has been increased during the season, and several important additions have been made to the library.

A portion of the station greenhouse has been made available for the use of the entomological department as an insectary. While not ideal in its appointments, this house will serve the purpose of an insectary, and render it possible to study certain insects under conditions which can be kept more nearly under control than if out of doors.

EXHIBITS.

Entomological exhibits were made at the annual meeting of the Connecticut Pomological Society at Hartford in February, and at the meeting of the State Board of Agriculture at Willimantic in December.

LECTURES.

The State Entomologist has given ten addresses and lectures before granges, village improvement societies, farmers' institutes, etc., during the year. Four of these were illustrated with lantern slides.

CORRESPONDENCE.

1037 letters have been written during the year on matters pertaining to the work of the department.

74 packages have been sent out by mail and express.

PUBLICATIONS FROM THE ENTOMOLOGICAL DEPARTMENT.

Fourth Report of State Entomologist, March, 1905. 112 pp., 16 plates, 11 figures. (12,000 copies.)

Bulletin 151, June, 1905. "The Chief Injurious Scale Insects of Connecticut," by W. E. Britton. 16 pp., 17 figures. (12,000 copies.)

Bulletin of Immediate Information, No. 1, October, 1905, "Combating the San José Scale in 1905," by W. E. Britton and B. H. Walden. 4 pp. (1,000 copies.)

"The Lime and Sulphur Wash Without Boiling," *Rural New Yorker*, March 4, 1905, by W. E. Britton. 4 mss. pages.

*"The Fall Web Worm Partially Double Brooded in Connecticut," by W. E. Britton. Bulletin No. 52, Bureau of Entomology, United States Department of Agriculture, p. 42. 1 page.

*"Addition to Our Knowledge of the Cabinet Beetle (*Anthrenus verbasci* Linn)," by H. L. Viereck, Bulletin No. 52, Bureau of Entomology, United States Department of Agriculture, p. 48. 1 page.

"Mosquitoes and Their Relation to Public Health," by W. E. Britton. (Read at Conference of Health Officers, Hartford, December, 1904. Report of State Board of Health for 1905.)

"Some New or Little Known *Aleyrodidae* from Connecticut," (describing *Aleyrodes actaeae*, a new species), by W. E. Britton, *Entomological News*, Vol. 16 (March), 1905, p. 65. 2 pp., 1 plate.

"Description of the Larva of *Delphastus pusillus* Lec., with Notes on the habits of the Species," by W. E. Britton, *Canadian Entomologist*, Vol. 37 (May), 1905, p. 185. 2 pp., 1 figure.

"Trees Injured by White Lead and Oil," by W. E. Britton, *Rural New Yorker*, July 15, 1905. 3 mss. pages, 1 figure.

"Poultry Pests," by W. E. Britton, *Connecticut Farmer*, September 9, 1905.

* Read at meeting of American Association of Economic Entomologists, Philadelphia, Pa., December, 1904. Proceedings published by Bureau of Entomology.

EXAMINATION OF ORCHARDS, GARDENS, ETC.

Forty-eight orchards, gardens and greenhouses have been inspected by the State Entomologist or his assistant, mostly by request of the owners. In addition, the office has once been called upon to examine a swamp near a village to learn if mosquitoes were breeding therein.

NURSERY INSPECTION.

Thirty-five nurseries have been inspected during the year, and thirty-four certificates granted. The form of the certificate is the same as has been issued for the past two years, and is reproduced in the third report for 1903, p. 206. The insect pest law regarding nursery inspection also remains unchanged, and is not reproduced in this report, but may be found on p. 200 of the report for 1903.

In general, as regards freedom from pests, the nurseries were found to be in better shape than in 1904. One or two exceptions showed negligence and lack of care, and a drastic cleaning up of these was required.

The nursery firms receiving certificates in 1905 were as follows:

LIST OF NURSERY FIRMS RECEIVING CERTIFICATES IN 1905.

Name of Firm.	Location.	Inspection Finished.	Certificate Number.
Allen, Chas. I.	Terryville	Nov. 1,	204
Atwater, C. W.	Collinsville	Sept. 25,	179
Barnes Bros. Nursery Co.	Yalesville	Oct. 12,	192
Beers, S. Perry	Greenfield Hill. ...	Oct. 3,	186
Bowditch, J. H.	Pomfret Center ..	Oct. 20,	199
Bridgeport Nursery Co.	Bridgeport	Nov. 10,	207
Burr & Co., C. R.	Manchester	Sept. 25,	180
Comstock & Lyon	Norwalk	Sept. 26,	181
Conine, F. E.	Stratford	Sept. 26,	182
Conn. Agricultural College	Storrs	Oct. 26,	201
Conway, W. B.	New Haven	Nov. 9,	206
Dehn & Bertolf	Greenwich	Oct. 17,	196
East Rock Park Nursery	New Haven	Oct. 11,	191
Elizabeth Park Nursery	Hartford	Sept. 22,	178
Elm City Nursery Co.	New Haven	Sept. 8,	174
Gardner's Nurseries	Cromwell	Sept. 29,	183
Gurney & Co., H. H.	New Canaan	Sept. 21,	177
Hale, J. H.	So. Glastonbury ..	Oct. 12,	193
Holcomb, Irving	Granby	Oct. 3,	185

Name of Firm.	Location.	Inspection Finished.	Certificate Number.
Hoyt's Sons Co., Stephen.....	New Canaan.....	Sept. 21,	176
Hunt & Co., W. W.	Hartford.....	Oct. 4,	187
Jewell, Harvey.....	Cromwell.....	Sept. 29,	184
Kellner, H. H.....	Danbury.....	Oct. 18,	197
Kelsey & Sons, David S.....	West Hartford...	Nov. 22,	208
Keney Park Nursery.....	Hartford.....	Oct. 28,	202
Norton, A. F.....	New Britain.....	Nov. 1,	203
Pierson, A. N.....	Cromwell.....	Sept. 18,	175
Platt Co., The Frank S.	New Haven.....	Sept. 27,	200
Ruedlinger, C. N.....	Hartford.....	Nov. 4,	205
Ryther, O. E.....	Norwich.....	Oct. 19,	198
Scofield, J. W.....	Hartford.....	Oct. 4,	188
Vidbourne & Co., J.....	Hartford.....	Oct. 16,	194
Woodruff, C. V.	Orange.....	Oct. 7,	189
Woodruff & Sons, S. D.	Orange.....	Oct. 7,	190

CHIEF LINES OF INVESTIGATION.

Scale-Insect Studies.—As in former years, considerable attention has been given to the destruction of the San José scale in Connecticut orchards by spraying, and several experiments were conducted. Over 6,000 trees, consisting of apple, pear, plum, but mostly of peach, were sprayed early in spring with various mixtures of lime and sulphur. The kerosene-limoid mixture was given a trial in comparison with these mixtures, but was not very satisfactory. A full account of these experiments is given in this report. Fumigation tests in destroying this insect on nursery stock are now in progress. We find that the scale breeds continuously throughout the winter on fruit trees in greenhouses.

The other kinds of scale-insects of Connecticut have been collected and studied, and a number of the most serious pests among them were figured and described in Bulletin No. 151.

Tobacco Insects.—The insects attacking tobacco in Connecticut have received attention from this office for three years. During 1905, however, more progress was made than has been possible before. Insects were collected from fields in different parts of the state, and their effect on the plants studied. A large number of tobacco worms were gathered, for the purpose of rearing adults, some of which emerged in the fall. As this investigation has not been finished, we have considered it best to withhold the publication of the results until

the work of at least one more year can be available to settle certain questions. Tobacco plants everywhere were severely attacked by cutworms, and a note regarding treatment recommended against this pest will be found on p. 260.

Mosquito Investigations.—The mosquito investigations described in the last report (1904, p. 253) were continued briefly during 1905. On account of a drought during May and another in July, there was much less stagnant water, and therefore less mosquito breeding, than in 1904. The territory about several inland towns and cities, including Farmington, New Britain and Rockville, was examined, and the results are included in this report. Upon request, a swamp area near the cemetery at Milford was examined, and a report made to the health officer of that town. See page 224.

Insects which Pollinate Fruit Blossoms.—Extensive collections have been made of the insects which visit the flowers of fruit trees and plants during the past two seasons. A complete list of these has been prepared, and is published on page 207 of this report, with the addition of notes regarding the relative value of the various species in carrying pollen.

The Connecticut Insect Fauna.—As mentioned in last year's report, a study of the insect fauna of Connecticut is being made, and this work has been continued through the season. The northeastern portion of the state was visited, Mr. Viereck making collections at Rockville, West Thompson and Putnam in July, and Mr. Britton at Stafford Springs the latter part of August. Torrington and Colebrook were also visited by Messrs. Britton and Viereck, and important collections were made. Mr. Walden collected extensively at Scotland in August, and much collecting was done on short trips around New Haven. Lists of Connecticut insects will eventually be published. Such lists of two orders (Orthoptera and Hymenoptera) are now being prepared under the direction of the State Entomologist, and will be published by the Geological and Natural History Survey of the State. Lists of other orders will be undertaken later. These lists are based upon the specimens in the station collection, though of course additional records are obtained wherever possible.

Tests of Insecticides.—In the course of the season there were opportunities for experiment in the destruction of insects by

means of various insecticides, and many such tests were made. Arsenate of lead has been used in a number of cases where an arsenical poison was needed, and has been found satisfactory.

General Observation on Injurious and Beneficial Insects.—Observation and records are constantly being made of insects causing injury to plants or animals, especially those forms which attack cultivated crops and shade trees. Parasites have been reared from many of the collected specimens.

ENTOMOLOGICAL FEATURES OF 1905.

Like the season of 1904, the preceding winter was unusually severe, and certain kinds of insect life were destroyed by it. About 35 per cent. of the over-wintering San José scales were killed. During the latter part of the season, however, the scales multiplied rapidly, and many trees were found thoroughly infested when not known to be infested early in the season.

Cutworms were extremely abundant, and did more damage than in 1904 or for several years. Corn, tobacco and other field crops were severely injured by them. Sweet corn, which is extensively grown for seed, had to be replanted in many cases. Tobacco had to be reset, in some instances several times. Vegetables of nearly all kinds in gardens and on truck farms were greatly injured by the attacks of cutworms. It seems strange that the large growers do not practice using the poisoned bait of bran mash which has so often been found successful.

The onion maggot, though still doing some damage, was much less injurious than in 1904. The cabbage maggot, however, did much damage in various parts of the state.

Woolly aphis is becoming more and more prevalent in young orchards and on nursery trees. On the roots, this insect is difficult to control, and some orchardists are now putting tobacco dust around the young trees when planting them. The apple aphis, *Aphis pomi* DeG., was not very abundant.

The elm leaf beetle still continues to decrease, and very little damage resulted from its attack on New Haven trees in 1905. Many of the elm trees were defoliated, but from a different cause. The white-marked tussock moth was more abundant in Connecticut than for ten years. In New Haven, trees in the eastern portion of the city were injured more than else-

where, and the insect was observed to be common in Hartford, Bridgeport and Norwalk.

The woolly maple leaf scale is beginning to attract attention as a pest of the sugar maple and specimens were sent in from three localities. This scale and the white-marked tussock moth are treated more fully in another part of this report.

The fall web worm was present everywhere, and denuded many trees in August and September.

The potato beetle was far more common than in 1903 or 1904.

COMBATING THE SAN JOSÉ SCALE IN 1905.

By W. E. BRITTON AND B. H. WALDEN.

In 1905 about 6,000 fruit trees were sprayed in our experiments. These were in five different orchards, and were situated as follows:

Westville	150 pear trees.
Middletown	68 peach "
Westport	125 " "
West Haven	395 " "
Southington	<u>5,271</u> peach and apple trees.
Total	6,009

SPRAY MIXTURES.

The spraying materials were chiefly lime and sulphur mixtures, and included the regular boiled mixture both with and without salt in comparison with three of the self-boiled mixtures, namely: lime, sulphur and sodium sulphide; lime, sulphur and caustic soda; lime, sulphur and sal soda. Kerosene-limoid mixture was also tested in competition with the lime and sulphur preparations. The mixtures were prepared after the formulas given below:

FORMULAS.

Mixture No. 1.	{ 20 lbs. lime. 14 lbs. sulphur. 40 galls. water. }	{ Light sulphur flour added dry to the slaking lime. Boiled 45-60 min- utes.
Mixture No. 2.	{ 20 lbs. lime. 14 lbs. sulphur. 10 lbs. salt. 40 galls. water. }	{ Light sulphur flour and salt added to the slaking lime. Boiled 45-60 minutes.

Mixture No. 3.	$\left\{ \begin{array}{l} 20 \text{ lbs. lime.} \\ 10 \text{ lbs. sulphur.} \\ 10 \text{ lbs. sodium sulphide.} \\ 40 \text{ galls. water.} \end{array} \right.$	$\left. \begin{array}{l} \text{Best whitewash or finishing} \\ \text{lime started slaking, sulphur} \\ \text{added. When at greatest} \\ \text{heat sulphide was added} \\ \text{with constant stirring.} \end{array} \right\}$
Mixture No. 4.	$\left\{ \begin{array}{l} 20 \text{ lbs. lime.} \\ 14 \text{ lbs. sulphur.} \\ 5 \text{ lbs. caustic soda.} \\ 40 \text{ galls. water.} \end{array} \right.$	$\left. \begin{array}{l} \text{Best whitewash or finishing} \\ \text{lime started slaking with hot} \\ \text{water, and sulphur added. When} \\ \text{at greatest heat, caustic soda} \\ \text{was added with constant stirring.} \end{array} \right\}$
Mixture No. 5.	$\left\{ \begin{array}{l} 20 \text{ lbs. lime.} \\ 14 \text{ lbs. sulphur.} \\ 10 \text{ lbs. sal soda.} \\ 40 \text{ galls. water.} \end{array} \right.$	$\left. \begin{array}{l} \text{Best whitewash or finishing lime} \\ \text{started slaking with hot water, and} \\ \text{sulphur added. When at greatest} \\ \text{heat sal soda was added with constant} \\ \text{stirring.} \end{array} \right\}$
Mixture No. 6.	$\left\{ \begin{array}{l} 40 \text{ lbs. limoid.} \\ 10 \text{ galls. kerosene.} \\ 30 \text{ galls. water.} \end{array} \right.$	$\left. \begin{array}{l} \text{Kerosene absorbed by the limoid} \\ \text{and stirred or churned violently to} \\ \text{mix with the water.} \end{array} \right\}$

As in previous tests, twigs were examined before treatment to ascertain how many scales had been winter-killed. By this method it is possible to represent more accurately the values of the different preparations as scale destroyers. This examination showed that on the average 35 per cent. of the wintering scales had been killed.

Twigs were cut late in June, just before the young began to appear, and a second count was made to determine the number and proportion killed by the spraying. A general examination of the orchards was made about October 1st.

To illustrate. If in the early spring count, out of 1,000 wintering scales examined 350 are found dead, we count 35 per cent. as winter-killed, leaving, out of every 1000 scales, 650 alive. If in June we find 25 alive out of every 1,000 scales counted, we assume that the spray has killed 625 out of every 650, which is equivalent to 96.1 per cent.

WESTVILLE EXPERIMENTS.

The pear trees treated are the same as described in the account of our spraying experiments of last year (see Bulletin 146, p. 11), and are owned by A. N. Farnham. They had been considerably injured by scale before any treatment was given them, so that while not now badly infested, many are unthrifty, and are not making a satisfactory growth. The spraying was done on March 28th, with a "Hardie" No. 6 pump, only self-boiled mixtures being used. Eighty trees were sprayed with lime, sulphur and caustic soda (formula

TABLE I.—EXPERIMENTS AT WESTVILLE.

Experiment numbers.	Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.
					Winter killed.	Killed by treatment.	Alive after treatment.	
4-31	Pear	80	Medium sized trees. Not vigorous. Moderately infested.	Formula No. 4— { 20 lbs. lime. 14 lbs. sulphur. 5 lbs. caustic soda. 40 galls. water. (Self-boiled.)	34	61.5	4.5	93.2
32-49	Pear	70	"	Formula No. 3— { 20 lbs. lime. 10 lbs. sulphur. 10 lbs. sodium sulphide. 40 galls. water. (Self-boiled.)	35	63.5	2.6	96
		150	"					

No. 4). The remaining seventy trees were sprayed with lime, sulphur and sodium sulphide (formula No. 3).

There was very little difference in the adhesive quality of the mixtures, and when the twigs were cut for the second examination in June, lime could be seen on the under sides of the branches and in the more protected places. Table I, page 198, shows the results. Formula No. 3 here gave a greater percentage efficiency than formula No. 4. When examined on October 2d, the trees were in fair shape, and about half had made good growth though many were not vigorous on account of previous injury. Living scales were found on most of the trees, but were most abundant on the outside rows, and reinfestation may have been responsible for it. Some trees bore fruit, and this was practically free from scale. A few trees only were infested with psylla.

WESTPORT EXPERIMENTS.

An orchard of small peach trees near the railroad, owned by Mr. S. B. Wakeman, was found during the winter to be moderately infested with scale. Plans were made to spray it, using both lime and sulphur and the kerosene-limoid mixtures. A portion of the trees were sprayed with the latter mixture, but on account of bad weather it was impossible to finish the work until the buds were open and too late to apply the lime and sulphur treatment. Table II, page 200, shows that over seven per cent. of the scales survived the treatment.

An examination of this orchard was made on October 17th, and though plenty of living scales could be found on most of the trees, there were few trees badly infested, and abundance of dead scales showed that the treatment was fairly satisfactory. As the other mixtures were not used in this orchard there is no basis for comparison.

EXPERIMENTS AT MIDDLETOWN.

These tests were made in a peach orchard of moderate size, owned by J. M. Hubbard & Son, and found during the winter to be infested with scale. The owners sprayed the entire orchard with the boiled lime and sulphur mixture. Sixty-eight trees were included in our tests, twenty-one being treated

TABLE II.—EXPERIMENTS AT MIDDLETOWN AND WESTPORT.

Experiment numbers.	Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.
					Winter killed.	Killed by treatment.	Alive after treatment.	
50-54	Peach	21	Medium sized bearing trees. Some had been injured by scale.	Formula No. 1— $\left\{ \begin{array}{l} 20 \text{ lbs. lime.} \\ 14 \text{ lbs. sulphur.} \\ 40 \text{ galls. water.} \end{array} \right.$ (Boiled.)	41	54.5	4.6	92.3
55-62	Peach	47 — 68	"	Formula No. 2— $\left\{ \begin{array}{l} 20 \text{ lbs. lime.} \\ 14 \text{ lbs. sulphur.} \\ 10 \text{ lbs. salt.} \\ 40 \text{ galls. water.} \end{array} \right.$ (Boiled.)	44	51.7	4.3	92.3
150-163	Peach	125*	Mostly small bearing trees. Some badly infested.	Formula No. 6— $\left\{ \begin{array}{l} 40 \text{ lbs. limoid.} \\ 10 \text{ galls. kerosene.} \\ 30 \text{ galls. water.} \end{array} \right.$	35	57.9	7.1	89

* Westport.

with lime and sulphur, and forty-seven being sprayed with lime, sulphur and salt. The mixture was cooked in the orchard by steam from a "Kinney Safe" engine, and applied with an "Eclipse" pump fitted with two lines of hose and double Vermorel nozzles. The results shown in Table II, page 200, indicate that the salt did not affect the mixture as a scale-destroyer.

When the twigs were cut in June, no difference was found in the sticking qualities of the two mixtures.

The final examination, made on October 5th, showed that the scale was well controlled throughout the entire orchard and but few living scales were found. Traces of the mixture still remained on many of the trees.

EXPERIMENTS AT WEST HAVEN.

These experiments were carried on in the peach orchard of Mr. N. S. Platt, on rather large trees of seven or eight years' planting. The orchard was more or less infested throughout, and some trees had been killed by scale.

The spray liquid was applied with a "Hardie" No. 6 pump mounted upon a drag. In these tests limoid and kerosene (formula No. 6) was tried in comparison with the self-boiled mixtures. A majority of the trees were sprayed with formula No. 3, formula No. 4 was used on more than a hundred trees, and a number of trees were left unsprayed.

Table III, page 202, shows formula No. 4 to have been rather more efficient than formula No. 3 in this orchard. Limoid and kerosene (formula No. 6) was less efficient than either of the others.

The final examination was made on October 2d, when the benefits of spraying were marked. Unsprayed trees were literally covered with living scales, while adjacent sprayed ones were nearly clean. Of course a few living ones could be seen on most of the trees, but they were more numerous on the trees treated with limoid and kerosene (formula No. 6) than on the other sprayed trees, though all were about equally situated as regards liability to reinfestation.

This last examination confirms the results expressed in figures in Table III, regarding the effectiveness of the mixtures. Trees treated with lime, sulphur and caustic soda (formula No. 4) and those sprayed with lime, sulphur and

TABLE III.—EXPERIMENTS AT WEST HAVEN.

Experiment numbers.	Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.
					Winter killed.	Killed by treatment.	Alive after treatment.	
64-88 214-220	Peach	213	Good sized bearing trees. Some had been injured by scale.	Formula No. 3— { 20 lbs. lime. 10 lbs. sulphur. 10 lbs. sodium sulphide. 40 galls. water. (Self-boiled.)	34	61.0	4.9	92.4
89-92 200-207	Peach	132	"	Formula No. 4— { 20 lbs. lime. 14 lbs. sulphur. 5 lbs. caustic soda. 40 galls. water. (Self-boiled.)	35	60.9	4.1	93.7
208-213	Peach	50 — 395	"	Formula No. 6— { 40 lbs. limoid. 10 galls. kerosene. 30 galls. water.	27	65.8	7.2	90.1

sodium sulphide (formula No. 3) were all remarkably free from living scales, though plenty of dead ones were found. A heavy rain the following night washed off some of the lime, sulphur and caustic soda (formula No 4), but did not greatly diminish its insecticidal value.

SOUTHINGTON EXPERIMENTS.

These experiments were conducted in the orchards of E. Rogers and J. H. Merriman in the Shuttle Meadow region of Southington. Some trees were badly infested, but most of them were uninjured. For the most part the boiled lime and sulphur mixture (formula No. 1) was used. One hundred and fifty trees were sprayed with formula No. 2 (containing salt), 240 with lime, sulphur and sodium sulphide mixture (formula No 3), 80 with lime, sulphur and sal soda (formula No. 5), and 85 with limoid and kerosene (formula No. 6). "Spramotor" pumps fitted with double lines of hose and mounted on wagons were used in this orchard. Both "Spramotor" and double "Vermorel" nozzles were employed. The mixture was boiled near the orchard in open barrels with steam from a "Kinney Safe" engine. It is always advisable where possible to place the cooking plant near a water supply. Mr. Rogers here used an ejector to draw water from a well, as is shown on plate I, b, and this was found to be a satisfactory arrangement. A neighbor, Mr. W. N. Dunham, sprayed several hundred trees, and for boiling the mixture used a small boiler of stationary pattern, though light and transportable. This boiler was not expensive, could be carried about in an express wagon, and was found satisfactory. His outfit is shown on plate I, a.

Table IV, page 204, shows the results. The highest percentage efficiency of treatment was given by the lime, sulphur and sodium sulphide mixture (formula No. 3); the lowest, by the kerosene and limoid mixture (formula No. 6).

When examined in June, the kerosene and limoid apparently had not injured the trees, and all sprayed trees were in good condition. When finally examined on October 9th, few living scales could be found on the sprayed trees in Mr. Rogers' peach orchard, though there were plenty of dead ones. Occasionally we noticed a small twig or branch with an abun-

TABLE IV.—EXPERIMENTS AT SOUTHTON.

Experiment numbers.	Kind of trees.	Number of trees treated.	Condition of trees after treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.
					Winter killed.	Killed by treatment.	Alive after treatment.	
93-98	Peach	4606	Medium sized trees not badly infested.	Formula No. 1— { 20 lbs. lime. 14 lbs. sulphur. 40 galls. water. (Boiled.) Formula No. 2— { 20 lbs. lime. 14 lbs. sulphur. 10 lbs. salt. 40 galls. water. (Boiled.) Formula No. 3— { 20 lbs. lime. 10 lbs. sulphur. 10 lbs. sodium sulphide. 40 galls. water. (Self-boiled.) Formula No. 5— { 20 lbs. lime. 14 lbs. sulphur. 10 lbs. sal soda. 40 galls. water. (Self-boiled.) Formula No. 6— { 40 lbs. limold. 10 galls. kerosene. 30 galls. water.	35	60.0	4.9	92.3
	Apple	110	Medium sized trees. Some badly infested.					
99-103	Peach	150	Bearing trees of medium size. Moderately infested.		39	56.5	4.5	92.6
	Peach	240	Small bearing trees. A few badly infested.		40	57.8	2.2	96.3
105-114	Peach	80	Small bearing trees. A few badly infested.		39	55.7	5.3	91.2
	Peach	85	Large trees, badly infested. Some killed by scale.		26	63.5	10.6	85.7
115-121								
122-129								
		5271						

dance of living scales, while the remainder of the tree was nearly free from them. These branches in all probability had not been well coated with the spray. The presence of salt in the mixture made no difference in the appearance of sprayed trees. Some medium-sized apple trees which were sprayed on a windy day were quite badly infested, but certain portions of the trees were also covered with dead scales, and the lack of thoroughness in spraying these trees doubtless accounts for their condition. Similar trees in Mr. Merriman's apple orchard were better sprayed, and are now comparatively free from scale. The young peach trees in the Merriman orchards are remarkably clean, and the October examination confirmed the figures obtained in June regarding the effectiveness of the self-boiled mixtures. Some large trees were sprayed with limoid and kerosene (25 per cent. kerosene) and the others with the boiled lime and sulphur mixture. Many of the former though thoroughly covered by the spray, and perfectly white after treatment, were found to be badly infested with living scales when examined in October. In adjoining rows, similar trees treated with lime and sulphur were comparatively free. This seems to indicate that (1) either the limoid and kerosene mixture was not as effective in killing the scales, or (2) that the scales more readily reëstablished themselves on trees sprayed with it.

The average percentage efficiency of each of these insecticides, for the localities where tested, may be found in Table V.

TABLE V.—PERCENTAGE EFFICIENCY OF INSECTICIDES.

FORMULA NO.	Percentage of Efficiency of Insecticides at					Average for these localities.
	West-ville	Middle-town.	West-port.	West Haven.	South-ington.	
1. Lime and sulphur	----	92.3	----	---	92.3	92.3
2. Lime, sulphur and salt . . .	..	92.3	----	----	92.0	92.5
3. Lime, sulphur and sodium sulphide	96.	----	----	92.4	96.3	94.9
4. Lime, sulphur and caustic soda	93.2	----	----	93.7	---	93.5
5. Lime, sulphur and sal soda . . .	----	----	----	----	91.2	91.2
6. Limoid and kerosene	---	---	89.	90.1	85.7	88.3

COST OF THE DIFFERENT MIXTURES.

The boiled lime and sulphur mixture without salt is the cheapest of all so far as the cost of materials is concerned.

The operation of boiling of course increases the cost, but probably this does not exceed fifteen or twenty cents per barrel of forty gallons where the proper kind of an outfit is employed. For use on a few trees in the back yard, or even for spraying an orchard of 200 or 300 trees, one of the self-boiled mixtures will probably be the least expensive if there is no convenient outfit for boiling at hand.

In reckoning the cost of materials, lime is figured at \$2.00 per barrel of 300 lbs., sulphur at \$2.85 per C., hay salt at 60 cts. per C., caustic soda (74 per cent.) in 25 lb. pails at 6 cts. per lb., sal soda, 2 cts. per lb., sodium sulphide in 110 lb. drums at 3½ cts., per lb., limoid at \$2.50 per bbl., and kerosene at 10 cts. per gallon; these being current prices for small quantities. In large lots the prices are considerably lower. The materials to make forty gallons or enough to fill a spray barrel of each of the various mixtures cost as follows:

Formula	No. 1	.....	\$ .54
"	No. 2	.....	.60
"	No. 3	.....	.78
"	No. 4	.....	.84
"	No. 5	.....	.74
"	No. 6	.....	1.66

WHERE MATERIALS MAY BE PURCHASED.

Lime may be purchased from dealers in all parts of the State. Mortar lime can be used in making a boiled mixture, but generally there is, in it, much more sediment to clog strainers and nozzles; therefore we recommend the use of whitewash or finishing lime, and in preparing a self-boiled mixture mortar lime should never be used.

Sulphur and caustic soda may be obtained through any wholesale drug firm, or may be purchased direct from dealers in New York.

Limoid is hydrated lime, and can be purchased from the manufacturers, The Charles Warner Company, Wilmington, Del. Sodium sulphide is sold by the Roessler & Hasslacher Chemical Company, 100 William St., New York City, and sal soda, hay salt and kerosene may be obtained anywhere from local merchants.

For a detailed account of the methods of preparing the various mixtures, and description of spraying apparatus, etc., the reader is referred to Bulletin No. 146, or to the report of this station for 1904, page 240.

SUMMARY.

1. About 6000 peach, apple and pear trees in Westville, Middletown, Westport, West Haven and Southington were sprayed in the spring of 1905 to destroy the San José scale.

2. The insecticides used were the boiled mixtures of lime and sulphur; lime, sulphur and salt; the self-boiled mixtures of lime, sulphur and sodium sulphide; lime, sulphur and caustic soda; and the kerosene and limoid mixture (see formulas, p. 196).

3. In these tests the lime, sulphur and sodium sulphide mixture gave the highest percentage efficiency, and the kerosene and limoid the lowest, though the difference was not striking, and all of the mixtures employed must be considered as fairly effective scale destroyers. The beneficial effect (if any) of salt in the boiled mixture was scarcely perceptible.

4. The cost of the materials is least for the boiled mixtures, and we recommend those where steam can be obtained for the purpose. The cost of boiling, however, makes the price nearly equal to the cost of the self-boiled mixture. Boiled lime and sulphur mixture is probably cheapest for the large orchard, and one of the self-boiled mixtures will prove cheapest for the small orchard and garden. Though somewhat easier to prepare and apply, the cost of the kerosene and limoid will make it prohibitory on a large scale.

A summarized account of these experiments was printed as Bulletin No. 1 of Immediate Information, containing four pages, and mailed to the Connecticut members of the Pomological Society in October. Only 1,000 copies were printed.

INSECTS COLLECTED FROM THE FLOWERS OF
FRUIT TREES AND PLANTS.*

BY W. E. BRITTON AND HENRY L. VIERECK.

For many years horticulturists and entomologists have regarded the honey bee, *Apis mellifera* Linn., as the most important species of insect engaged in the pollination of the flowers of our fruit-bearing trees and shrubs. Benton states† that bees are the most abundant of the insects visiting the

* This paper as originally prepared was read before the meeting of the American Association of Economic Entomologists at Philadelphia, December 29 and 30, 1904, but was withdrawn from publication in the proceedings of that meeting, and has not until this time been published. The paper has been emended and rearranged, and contains important additions.

† Frank Benton, The Honey Bee, Bulletin I, Division of Entomology, p. 63.

fruit blossoms. In his study of the pollination of pear flowers ten years ago, Waite found about fifty different kinds of insects visiting pear blossoms, but that the common honey bee was "the most regular and important abundant visitor, and probably does more good than any other species."* In an address before the Georgia State Horticultural Society in 1903, Professor Wilmon Newell stated that "no insect so effectually accomplishes this distribution of pollen as the honey bee."† According to Müller also the honey bee is an abundant visitor of plum, pear, apple, currant and gooseberry flowers in Europe.‡

The importance of honey bees in pollinating fruit flowers has been pointed out by a great number of popular and technical writers, and we were somewhat surprised in looking over the results of a few minutes' collecting in the garden in 1904 to find that honey bees were exceedingly scarce in comparison with other species of *Hymenoptera*,—or in fact with other insects. Observations were therefore continued on some of our common fruit trees. No attempt is here made to give a complete list of the insect visitors of these plants. The lists represent only the insects taken from the flowers and in sweeping over them. The collecting was done mostly by the writers at odd moments during sunny forenoons on the grounds of the Experiment Station in New Haven. The dates of the collecting were from May 4th to May 14th, 1904, during which time currant, gooseberry, apple, pear, plum and cherry were in bloom; the insects from blackberry flowers were taken June 3d, 1904. During 1905 many specimens were taken from apple and quince flowers at Branford by Rev. H. W. Winkley, and the results are incorporated in this paper. The Branford specimens were collected from May 11th to May 22d. During this time Mr. B. H. Walden also collected insects on quince, cherry, peach, raspberry and strawberry at New Haven. The accompanying list contains the results of all these collections.

It is not known to the writers that bees are kept in the immediate vicinity of the Experiment Station; there are

* M. B. Waite, The Pollination of Pear Flowers, Bulletin V, Division of Vegetable Pathology, p. 79.

† Proceedings, 27th Annual Meeting, Georgia State Horticultural Society, 1903.

‡ H. Müller, The Fertilization of Flowers (Thompson's translation).

several hives less than two miles away. Wild honey bees are probably not very abundant so near the city. We should expect them to be much more abundant at Branford.

The writers desire to express their obligations to Mr. C. W. Johnson of Boston for determining the *Diptera*. The *Hymenoptera* have been identified by Mr. Viereck.

The species of plants collected from, together with the number of specimens and species of insects taken from each, is as follows:—

Plant.	No. of Insects.	No. of Species.
<i>Ribes oxycanthoides</i> , American Gooseberry.....	883	72
" <i>rubrum</i> , Common Red Currant.....	123	59
" <i>nigrum</i> , Common Black Currant.....	154	23
<i>Prunus</i> sp. (probably a native species).....	39	15
" <i>triloba</i> , Japan Plum.....	405	44
" <i>avium</i> , Sweet Cherry.....	370	37
" <i>persica</i> , Peach	12	8
<i>Pyrus malus</i> , Common Apple.....	229	52
" <i>communis</i> , Common Pear.....	73	29
<i>Cydonia vulgaris</i> , Common Quince.....	77	30
<i>Rubus nigrobaccus</i> , Common High Bush Blackberry	18	8
" <i>strigosus</i> , Red Raspberry.....	22	13
<i>Fragaria virginiana</i> , Strawberry.....	11	6
Total	2,416	396

The following list shows the number of species in each order, so far as they could be determined, with the number of specimens of each species.

In the *Hymenoptera*, the sexes have been recorded separately, but workers or neuters are enumerated only in the column of totals. It will be seen that the females greatly predominate.

LIST OF INSECTS COLLECTED FROM THE FLOWERS OF FRUIT TREES AND PLANTS.

American Gooseberry, *Ribes oxycanthoides*.

HYMENOPTERA (Bees, wasps, ants).	Male	Female	Total No. Specimens
<i>Pteronus ribesii</i> Scop.		7	7
<i>Dolerus aprilis</i> Nort.		1	1
<i>Bracon</i> sp.		3	3
<i>Doryctes</i> ? sp.		2	2
<i>Apanteles</i> sp.		..	4
<i>Dacnusa</i> ? sp.		..	2
<i>Sympratis</i> ? sp.		1	1
<i>Thersilochus</i> sp.		4	4
Undetermined Tryphonids (4 species) ..		..	4
" Chalcidids (4 species) ..		..	5
<i>Lasius</i> sp.		..	1
<i>Colletes inaequalis</i> Cress.	1	2	3
" <i>valida</i> Cress.	5	1	6
<i>Halictus fasciatus</i> Nyl.		26	26
" <i>lerouxii</i> Lep.		30	30
" (<i>Evylaeus</i>) <i>arcuatus</i> Robt.		19	19
" " <i>truncatus</i> Robt.		9	9
" " <i>pectinatus</i> Robt. ?		1	1
" (<i>Chloralictus</i>) <i>pilosus</i> Sm.		32	32
" " sp.		20	20
" " <i>zephyrus</i> Sm.		4	4
" " sp.		31	31
" " " 		2	2
" " " 		14	14
" " <i>sparsus</i> Robt.		417	417
<i>Trachandrena forbesii</i> Robt.	4	4	8
" " var.	1	1	2
" sp.	1	..	1
" sp.	1	..	1
" sp.	..	1	1
" <i>crataegi</i> Robt.	4	..	4
<i>Andrena carlini</i> Ckll.		1	1
" <i>vicina</i> Sm.	50	4	54
" <i>nasoni</i> Robt.	8	5	13
" <i>salicacea</i> Robt.	1	1	1
" (<i>Opandrena</i>) <i>bipunctata</i> Cress.	1	6	7
" sp.	5	2	7
<i>Nomada imbricata</i> Sm.		1	1
<i>Ceratina dupla</i> Say.	2	7	9
<i>Synhalonia atriventris</i> Sm.	2	..	2
Total, 46 species	85	659	760

DIPTERA (Flies, mosquitoes).

	Specimens
<i>Ceratopogon fuscus</i> Coq.	10
<i>Rhamphomyia nana</i> Loew.	1
<i>Lonchoptera lutea</i> Panz.	20
" <i>riparia</i> Meig.	20
<i>Eristalis bastardi</i> Macq.	2
<i>Panzeria radicum</i> Fabr.	4
<i>Homalomyia scalaris</i> Fabr.	1
<i>Phorbia fusciceps</i> Zett.	3
<i>Fucellia fucorum</i> Fall.	2
<i>Scatophaga stercoraria</i> Linn.	6
<i>Chlorops assimilis</i> Macq.	8
<i>Elachiptera costata</i> Loew.	19
<i>Oscinis coxendix</i> Fitch.	3
" <i>sp.</i>	1
<i>Drosophila graminum</i> Fall.	1
" <i>sp.</i>	2
<i>Agromyza angulata</i> Loew.	2
<i>Desmometopa m-nigrum</i> Zett.	1
" <i>latipes</i> Meig.	1

Total, 19 species 107

COLEOPTERA (Beetles).

	Specimens
<i>Phyllotreta sinuata</i> Steph.	1
<i>Epitrix cucumeris</i> Harris.	2
<i>Diabrotica vittata</i> Fabr.	1
<i>Adalia bipunctata</i> Linn.	1

Total, 4 species 5

HEMIPTERA (Bugs, leaf-hoppers, etc.).

	Specimens
<i>Lygus pratensis</i> Linn.	4
Undetermined Tettigoniid	1
" Jassid	6

Total, 3 species 11

Common Red Currant, *Ribes rubrum*.

HYMENOPTERA (Bees, wasps, ants).

	Male	Female	Total No. Specimens
<i>Dolerus aprilis</i> Nort.	1	1	2
<i>Apanteles sp.</i>	1	..	1
" "	1	1	1
<i>Sympratis ? sp.</i>	..	1	1
<i>Exochus semirufus</i> Cress.	1	..	1
Undetermined Tryphonid	..	..	1
<i>Ichneumon subcyaneus</i> Cress.	1	..	1
" <i>seminiger</i> Cress.	..	1	1
Undetermined Chalcidid	..	..	1
" "	..	..	1
<i>Crematogaster lineolata</i> Say.	..	..	1

HYMENOPTERA (Bees, wasps, ants)—*Cont'd.*

	Male	Female	Total No. Specimens
<i>Cryptocheilus conicus</i> Say.	1	..	1
<i>Colletes valida</i> Cress.	2	..	2
<i>Oxytroglossa similis</i> Robt.	..	1	1
<i>Halictus fasciatus</i> Nyl.	..	1	1
" (<i>Eurylaeus</i>) <i>truncatus</i> Robt.	..	1	1
" (<i>Chloralictus</i>) <i>zephyrus</i> Sm.	..	7	7
" " <i>sp.</i>	..	13	13
" " <i>sparsus</i> Robt.	..	3	3
" " <i>n. sp.</i> ?.....	..	1	1
" " <i>n. sp.</i>	..	1	1
<i>Trachandrena crataegi</i> Robt.	3	..	3
" <i>forbesii</i> Robt.	1	..	1
" " var.	1	1	2
<i>Andrena mandibularis</i> Robt.	..	1	1
" <i>nasoni</i> Robt.	3	1	4
" <i>vicina</i> Sm.	3	..	3
" <i>sp.</i>	1	..	1
Total, 28 species	19	35	58

DIPTERA (Flies, mosquitoes).

	Specimens
Undetermined Chironomid	1
<i>Sciara sp.</i>	1
<i>Rhamphomyia brevis</i> Loew.	1
<i>Pipiza albipilosa</i> Will.	1
" <i>femoralis</i> Loew.	1
<i>Melanostoma mellinum</i> Linn.	1
<i>Hyalomyodes triangulifera</i> Loew.	1
<i>Panzeria radicum</i> Fabr.	4
<i>Sarcophaga heliciis</i> Town.	1
" <i>sp.</i>	1
" "	1
<i>Lucilia caesar</i> Linn.	1
<i>Phormia regina</i> Meig.	1
<i>Ophyra leucostoma</i> Wied.	1
<i>Anthomyia radicum</i> Linn.	3
<i>Phorbia cinerella</i> Fall.	1
" <i>fusciceps</i> Zett.	16
<i>Fucellia fucorum</i> Fall.	2
<i>Scatophaga stercoraria</i> Linn.	6
<i>Sepsis violacea</i> Meig.	1
<i>Nemopoda cylindrica</i> Fabr.	1
<i>Piophilha casei</i> Linn.	8
<i>Chlorops variceps</i> Loew.	1
<i>Oscinis coxendrix</i> Fitch.	2
<i>Agromyza diminuta</i> Walk.	1
<i>Desmometopa latipes</i> Meig.	1
" <i>m-nigrum</i> Zett.	1
Total, 27 species	61

COLEOPTERA (Beetles).

	Specimens
<i>Anthrenus verbasci</i> Linn.	1
<i>Adalia bipunctata</i> Linn.	1

Total, 2 species 2

HEMIPTERA (Bugs, leaf-hoppers, etc.).

	Specimens
<i>Lygus pratensis</i> Linn.	1
Undetermined Psyllid	1

Total, 2 species 2

Black Currant, *Ribes nigrum*.

HYMENOPTERA (Bees, wasps, ants).

	Male	Female	Total No. Specimens
<i>Apanteles</i> sp.	1	..	1
<i>Thersilochus</i> sp.	..	3	3
<i>Vespa germanica</i> Fabr.	..	1	1
<i>Agapostemon radiatus</i> Say.	..	1	1
<i>Halictus lerouxii</i> Lep.	..	2	2
" (<i>Evylaeus</i>) <i>arcuatus</i> Robt.	..	6	6
" " <i>truncatus</i> Robt.	..	19	19
" (<i>Chloralictus</i>) <i>sparsus</i> Robt.	..	81	81
" " <i>zephyrus</i> Sm.	..	9	9
" " sp.	..	2	2
" " "	..	4	4
" " <i>pilosus</i> Sm.	..	8	8
<i>Andrena vicina</i> Sm.	2	..	2
<i>Bombus consimilis</i> Cress.	..	1	1
" <i>pennsylvanicus</i> DeG.	..	1	1

Total, 15 species 3 138 141

DIPTERA (Flies, mosquitoes).

	Specimens
<i>Eristalis bastardi</i> Macq.	1
<i>Lucilia caesar</i> Linn.	3
<i>Scatophaga stercoraria</i> Linn.	2
<i>Nemopoda cylindrica</i> Fabr.	1
<i>Piophilila casei</i> Linn.	1
<i>Chlorops assimilis</i> Macq.	1
<i>Phorbia fusciceps</i> Zett.	3

Total, 7 species 12

COLEOPTERA (Beetles).

	Specimen
<i>Adalia bipunctata</i> Linn.	1

Total, 1 species 1

Wild Plum, *Prunus sp.*

HYMENOPTERA (Bees, wasps, ants).

	Male	Female	Total No. Specimens
<i>Halictus (Evylaeus) arcuatus</i> Robt.	..	I	I
<i>Trachandrena crataegi</i> Robt.	I	3	4
<i>Andrena vicina</i> Sm.	..	I	I
" <i>salicacea</i> Robt.	..	I	I
" (<i>Opandrena</i>) <i>bipunctata</i> Cress.	..	18	18
Total, 5 species	I	24	25

DIPTERA (Flies, mosquitoes).

	Specimens
<i>Ceratopogon fuscus</i> Coq.	I
Undetermined Chironomid	2
<i>Stratiomyia discalis</i> Loew.	I
<i>Odontomyia pubescens</i> Day.	I
<i>Hilaria leucoptera</i> Loew.	2
<i>Triodonta curvipes</i> Wied.	I
<i>Zodion fulvifrons</i> Say.	I
<i>Nemopoda minuta</i> Wied.	3
Total, 8 species	12

COLEOPTERA (Beetles).

	Specimens
<i>Crepidodera helxinus</i> Linn.	I
<i>Attagenus piceus</i> Oliv.	I
Total, 2 species	2

Japan Plum, *Prunus triloba*.

HYMENOPTERA (Bees, wasps, ants).

	Male	Female	Total No. Specimens
<i>Sympratis</i> ? <i>sp.</i>	..	I	I
<i>Aphanogmus</i> ? <i>sp.</i>	..	I	I
<i>Formica fusca subsericea</i> Say.	..	..	4
<i>Ancistrocerus tigris</i> Saus.	I	..	I
<i>Colletes inaequalis</i> Cress.	..	I	I
<i>Halictus fasciatus</i> Nyl.	..	I	I
" <i>lerouxii</i> Lep.	..	I	I
" (<i>Evylaeus</i>) <i>arcuatus</i> Robt.	..	7	7
" " <i>truncatus</i> Robt.	..	5	5
" (<i>Chloralictus</i>) <i>pilosus</i> Sm.	..	I	I
" " <i>sephyrus</i> Sm.	..	I	I
" " <i>sparsus</i> Robt.	..	207	207
" " <i>sp.</i>	..	3	3
<i>Paralictus cephalicus</i> Robt.	..	I	I
<i>Trachandrena crataegi</i> Robt.	13	3	16
" <i>claytoniae</i> Robt.	..	I	I
" <i>forbesii</i> Robt.	I	3	4
" " var.	..	I	I
" <i>sp.</i>	..	I	I

HYMENOPTERA (Bees, wasps, ants)—*Cont'd.*

	Male	Female	Total No. Specimens
<i>Andrena vicina</i> Sm.	..	4	4
" <i>nasoni</i> Robt.	6	4	10
" <i>salicacea</i> Robt.	..	2	2
" (<i>Opandrena</i>) <i>bipunctata</i> Cress.	19	65	84
Total, 23 species	40	314	358

DIPTERA (Flies, mosquitoes).

	Specimens
<i>Ceratopogon fuscus</i> Coq.	1
<i>Camptocladus byssinus</i> Schr.	9
<i>Sciara</i> sp.	1
Undetermined Empid	2
<i>Platychirus hypoboreus</i> Staeg.	4
<i>Panzeria radicum</i> Fabr.	2
<i>Cynomyia cadaverina</i> Desv.	1
<i>Phormia regina</i> Meig.	1
<i>Hyetodesia lucorum</i> Fall.	1
<i>Phorbia fusciceps</i> Zett.	6
Undetermined Anthomyid	1
<i>Scatophaga stercoraria</i> Linn.	3
<i>Sepsis violacea</i> Meig.	1
<i>Nemopoda stercoraria</i> Desv. ?	1
<i>Piophilha casei</i> Linn.	7
<i>Chlorops assimilis</i> Macq.	1
Total, 16 species	42

COLEOPTERA (Beetles).

	Specimens
<i>Crepidodera helxinus</i> Linn.	1
<i>Aphodius granarius</i> Linn.	1
<i>Anthrenus scrophulariae</i> Linn.	1
<i>Xantholinus cephalus</i> Say.	1
<i>Adalia bipunctata</i> Linn.	1
Total, 5 species	5

Sweet Cherry, *Prunus avium*.

HYMENOPTERA (Bees, wasps, ants).

	Male	Female	Total No. Specimens
<i>Apanteles</i> sp.	..	..	1
Undetermined Cynipid	..	..	1
<i>Vespa diabolica</i> Saus.	..	1	1
<i>Colletes inaequalis</i> Cress.	..	1	1
<i>Agapostemon radiatus</i> Say.	..	2	2
<i>Halictus fasciatus</i> Nyl.	..	5	5
" <i>lerouxii</i> Lep.	..	1	1
" (<i>Evyllaesus</i>) <i>arcuatus</i> Robt.	..	14	14
" " <i>truncatus</i> Robt.	..	7	7

HYMENOPTERA (Bees, wasps, ants)—Cont'd.

	Male	Female	Total No. Specimens
<i>Halictus (Chloralictus) zephyrus</i> Sm.		15	15
" " <i>pilosus</i> Sm.		14	14
" " <i>sparsus</i> Robt.		185	185
" " <i>obscurus</i> Robt. ?....		1	1
" " <i>n. sp.</i>		1	1
" " <i>sp.</i>		2	2
" " "		7	7
" " "		7	7
<i>Trachandrena crataegi</i> Robt.		1	1
" <i>forbesii</i> Robt.	1	..	1
" " var.		3	3
" <i>claytoniae</i> Robt.		1	1
" <i>hippotes</i> Robt.		1	1
<i>Andrena vicina</i> Sm.	2	13	15
" <i>mandibularis</i> Robt.		3	3
" <i>nasoni</i> Robt.	12	2	14
" <i>carlini</i> Ckll.	1	1	2
" (<i>Opandrena</i>) <i>bipunctata</i> Cress.	7	40	47
<i>Bombus virginicus</i> Oliv.		1	1
<i>Apis mellifera</i> Linn.		..	5
Total, 29 species	23	329	359

DIPTERA (Flies, mosquitoes).

	Specimens
Undetermined Chironomid	1
<i>Xylota ejuncida</i> Say.	1
<i>Phorbia fusciceps</i> Zett.	2
<i>Piophila casei</i> Linn.	3
Total, 4 species	7

COLEOPTERA (Beetles).

	Specimens
<i>Crepidodera helxinus</i> Linn.	1
<i>Epuraea labilis</i> Er.	1
<i>Carpophilus discoideus</i> Lec.	1
<i>Adalia bipunctata</i> Linn.	1
Total, 4 species	4

Peach, *Prunus persica*.

HYMENOPTERA (Bees, wasps, ants).

	Male	Female	Total No. Specimens
<i>Halictus (Chloralictus) versatus</i> Robt.		1	1
" " <i>n. sp.</i>		1	1
" " <i>obscurus</i> Robt.		3	3
" " <i>sparsus</i> Robt.		2	2
<i>Andrena (Opandrena) bipunctata</i> Cress.		2	2
<i>Bombus virginicus</i> Oliv.		..	1
" <i>ridingsii</i> Cress.		..	1
<i>Apis mellifera</i> Linn.		..	1
Total, 8 species	0	9	12

Apple, *Pyrus malus*.

HYMENOPTERA (Bees, wasps, ants).

	Male	Female	Total No. Specimens
<i>Caliroa</i> ? sp.		1	1
<i>Amblyteles</i> sp.		1	1
<i>Camponotus pennsylvanicus</i> DeG.	..		2
<i>Formica fusca subsericea</i> Say.	..		1
<i>Vespa maculata</i> Linn.		1	1
" <i>diabolica</i> Sauss.		1	1
<i>Agapostemon radiatus</i> Say.		2	2
<i>Halictus lerouxii</i> Lep.		4	4
" (<i>Chloralictus</i>) <i>zephyrus</i> Sm.		11	11
" " <i>pilosus</i> Sm.		5	5
" " <i>sparsus</i> Robt.		30	30
" " <i>obscurus</i> Robt.		1	1
" " <i>versatus</i> Robt.		6	6
" " <i>sp.</i>		..	3
" " "		..	4
" (<i>Evylaeus</i>) <i>truncatus</i> Robt.		1	1
<i>Andrena nasoni</i> Robt.		1	1
" <i>vicina</i> Sm.		5	5
" <i>carlini</i> Ckll.		6	6
" <i>sp.</i>	4	..	4
" (<i>Opandrena</i>) <i>bipunctata</i> Cress.	1	11	12
<i>Trachandrena claytoniae</i> Robt.		1	1
" <i>crataegi</i> Robt.		1	1
" <i>hippotes</i> Robt.		1	1
<i>Synhalonia atriventris</i> Sm.	1	..	1
<i>Osmia (Ceratosmia) lignaria</i> Say.		34	34
<i>Xylocopa virginica</i> Dru.	15	..	15
<i>Bombus ridingsii</i> Cress.		1	1
" <i>americanorum</i> Fabr.		1	1
" <i>consimilis</i> Cress.	5	2	7
" <i>virginicus</i> Oliv.		2	2
<i>Apis mellifera</i> Linn.		..	31
Total, 32 species	26	130	197

DIPTERA (Flies, mosquitoes).

	Specimens
<i>Ceratopogon</i> sp.	1
<i>Chironomus modestus</i> Say.	1
Undetermined Cecidomyid	1
<i>Chrysogaster pulchella</i> Will.	1
<i>Helophilus hamatus</i> Loew.	1
<i>Triodonta curvipes</i> Wied.	1
<i>Sarcophaga helioides</i> Town.	1
<i>Lucilia caesar</i> Linn.	1
<i>Homalomyia scalaris</i> Fabr.	3

DIPTERA (Flies, mosquitoes)—*Cont'd.*

	Specimens
<i>Anthomyia radicum</i> Linn.	1
<i>Phorbia cinerella</i> Fall.	1
" <i>fusciceps</i> Zett.	4
Undetermined Anthomyid	1
<i>Scatophaga stercoraria</i> Linn.	1
<i>Lonchaea rufitarsis</i> Macq.	1
<i>Piophilha casei</i> Linn.	4
Total, 16 species	24

COLEOPTERA (Beetles).

	Specimens
<i>Telephorus bilineatus</i> Say.	2
<i>Adalia bipunctata</i> Linn.	1
<i>Bradycellus rupestris</i> Say.	4
Total, 3 species	7

HEMIPTERA (Bugs, leaf-hoppers, etc.).

	Specimen
<i>Miris affinis</i> Reut.	1

Pear, *Pyrus communis*.

HYMENOPTERA (Bees, wasps, ants).

	Male	Female	Total No. Specimens
<i>Nematus</i> sp.		1	1
<i>Agapostemon radiatus</i> Say.		2	2
<i>Paralictus cephalicus</i> Robt.		1	1
<i>Halictus fasciatus</i> Nyl.		1	1
" (<i>Evylaeus</i>) <i>arcuatus</i> Robt.		1	1
" " <i>truncatus</i> Robt.		2	2
" (<i>Chloralictus</i>) <i>sparsus</i> Robt.		3	3
" " <i>n. sp.</i>		1	1
" " <i>zephyrus</i> Sm.		1	1
" " <i>sp.</i>		4	4
<i>Trachandrena crataegi</i> Robt.	3	1	3
" <i>forbesii</i> Robt.		1	1
" <i>claytoniae</i> Robt.		1	1
<i>Andrena vicina</i> Sm.		1	1
" <i>nasoni</i> Robt.	6	12	18
" <i>macgillivrayi</i> Ckll. var.		1	1
" (<i>Opandrena</i>) <i>bipunctata</i> Cress.	3	8	11
Total, 17 species	12	40	53

DIPTERA (Flies, mosquitoes).

	Specimens
Undetermined Chironomid	2
<i>Tachydromia pusilla</i> Loew.	3
<i>Platychirus hypoboreus</i> Staeg.	1
<i>Metachaeta helynus</i> Walk.	1

DIPTERA (Flies, mosquitoes)—*Cont'd.*

	Specimens
Undetermined Tachinid	1
<i>Morellia micans</i> Macq.	1
<i>Phorbia fusciceps</i> Zett.	3
<i>Piophilha casei</i> Linn.	4
<i>Chlorops assimilis</i> Macq.	1
Total, 9 species	17

COLEOPTERA (Beetles).

	Specimens
<i>Diabrotica vittata</i> Fabr.	1
<i>Anthrenus scrophulariae</i>	1
<i>verbasci</i>	1
Total, 3 species	3

Quince, *Cydonia vulgaris*.

HYMENOPTERA (Bees, wasps, ants).

	Male	Female	Total No. Specimens
<i>Exochus pallipes</i> Cress.		1	1
<i>Formica fusca subcericea</i> Say.		..	2
<i>Odynerus (Ancistrocerus) campestris</i> Sauss. ..		..	1
<i>Halictus lerouxii</i> Lep.		1	1
<i>fasciatus</i> Nyl.		9	9
<i>(Lasioglossum) coriaceum</i> Sm.		1	1
<i>(Eurylaeus) truncatus</i> Robt.		3	3
<i>(Chloralictus) pilosus</i> Sm.		5	5
" <i>sephyrus</i> Sm.		2	2
" <i>tegularis</i> Robt.		6	6
" <i>sparsus</i> Robt.		18	18
" <i>obscurus</i> Robt. ? ...		1	1
" <i>versatus</i> Robt.		3	3
" <i>sp.</i>		1	1
<i>Andrena (Opandrena) bipunctata</i> Cress.		2	2
" <i>nasoni</i> Robt.		3	3
<i>Trachandrena crataegi</i> Robt.	1	1	2
<i>Ceratina dupla</i> Say.	1	..	1
<i>Osmia (Ceratosmia) lignaria</i> Say.		..	1
<i>Bombus virginicus</i> Oliv.		1	1
" <i>consimilis</i> Cress.		1	1
<i>Apis mellifera</i> Linn.		..	3
Total, 22 species	2	58	68

DIPTERA (Flies, mosquitoes).

	Specimens
<i>Tachydromia pusilla</i> Loew.	2
<i>Mesogramma marginala</i> Say.	1
<i>Tropidia quadrata</i> Say.	1
<i>Syrirta pipiens</i> Linn.	1
<i>Ophyra leucostoma</i> Wied.	1
<i>Nemopoda cylindrica</i> Fabr.	1
<i>Agromyza aeneiventris</i> Fall.	1
Total, 7 species	8

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COLEOPTERA (Beetles).

	Specimens
<i>Diabrotica vittata</i> Fabr.	1

Common Blackberry, *Rubus nigrobaccus*.

HYMENOPTERA (Bees, wasps, ants).	Male	Female	Total No. Specimens
<i>Prenolepis imparis</i> Say.	..	..	2
<i>Halictus (Chloralictus) sp.</i>	..	1	1
<i>Trachandrena forbesii</i> var.	..	1	1
" <i>sp.</i>	1	..	1
<i>Andrena (Opandrena) bipunctata</i> Cress.	3	7	10
<i>Bombus americanorum</i> Fabr.	..	1	1
" <i>ridingsii</i> Cress.	..	..	1
<i>Apis mellifera</i> Linn.	..	..	1
Total, 8 species	4	10	18

Red Raspberry, *Rubus strigosus*.

HYMENOPTERA (Bees, wasps, ants).	Male	Female	Total No. Specimens
<i>Eumenes fraterna</i> Say.	..	..	1
<i>Odynerus pennsylvanicus</i> Sauss.	..	..	1
<i>Prosopis affinis</i> Sm.	..	2	2
" <i>pygmaea</i> Cress.	..	1	1
<i>Halictus fasciatus</i> Nyl.	..	1	1
" (<i>Chloralictus</i>) <i>sparsus</i> Robt.	..	1	1
<i>Andrena sp.</i>	..	1	1
" <i>hilaris</i> Sm. ?	..	1	1
<i>Ceratina dupla</i> Say.	..	4	4
<i>Alcidamea producta</i> Cress.	1	1	2
<i>Celiorys sp.</i>	1	..	1
<i>Osmia pumila</i> Cress.	..	4	4
<i>Bombus ridingsii</i> Cress.	1	1	2
Total, 13 species	3	17	22

Strawberry, *Fragaria virginiana*.

HYMENOPTERA (Bees, wasps, ants).	Male	Female	Total No. Specimens
<i>Formica sp.</i>	..	..	1
<i>Halictus fasciatus</i> Nyl.	..	2	2
" (<i>Chloralictus</i>) <i>versatus</i> Robt.	..	5	5
<i>Trachandrena claytoniae</i> Robt.	..	..	1
Total, 4 species	0	7	9

COLEOPTERA (Beetles).

	Specimens
<i>Crepidodera helxinus</i> Linn.	1
<i>Byturus unicolor</i> Say.	1

Total, 2 species 2

RELATIONSHIP BETWEEN THE FLOWERS AND THEIR INSECT VISITORS.

It will be noticed that the Hymenoptera are more abundant on the blossoms of these fruits than are the other orders of insects. A majority of the Hymenoptera in these collections—majority of both species and individuals—belong to the superfamily *Apoidea*, which includes the honey bee and the bumble bee. These bees are known to gather pollen and nectar for their young, and this explains their visits to the flowers. In each of the lists of hymenoptera most of the species are bees. Beginning with *Colletes*, or in some cases with *Agapostemon* and *Halictus*, all others on the lists belong to the *Apoidea*.

Just what the other insects are doing in the flowers is more uncertain. It is known that certain beetles feed upon pollen, and doubtless the flies and parasitic hymenoptera are attracted by the nectar upon which they may feed.

Let us first consider the *Hymenoptera*. It will be noticed from the foregoing list that by far the most abundant visitors to these flowers were the small bees belonging to the *Halictidae* called "sweat bees," and the *Andrenidae*. These have long been known to be important agents in the transfer of pollen.

Of the 760 specimens collected on *Ribes oxycanthoides*, 417, or more than half, were *Halictus (Chloralictus) sparsus* Robt. Other species important to the plant on account of their numbers were *Halictus fasciatus* Nyl. 26, *H. lerouxii* Lep. 30, *H. (Evylaeus) arcuatus* Robt. 19, *H. (Chloralictus) pilosus* Sm. 32, *Andrena vicina* Sm. 54, *A. nasoni* Robt. 13, and three species of *Halictus (Chloralictus)* which are probably new, represented respectively by 20, 31 and 14 specimens.

On the red currant we find some of the same species, but the proportions are entirely different. Here one of the new species of *Halictus (Chloralictus)* was the most abundant, and was represented by 13 specimens out of 58. *C. zephyrus* Sm. had 7 examples, while the other 26 species are each represented by less than 4 specimens.

Of 141 specimens taken from black currant, 81 were *Halictus (Chloralictus) sparsus* Robt., 19 *H. (Evylaeus) truncatus* Robt., 9 *H. (Chloralictus) zephyrus* Sm., 8 *H. (C.) pilosus* Sm., and 6 *H. (Evylaeus) arcuatus* Robt.

The undetermined *Prunus* was visited chiefly by *Andrena* (*Opandrena*) *bipunctata* Cress., 18 out of the 25 specimens of *Hymenoptera* being that species.

358 specimens of *Hymenoptera* were collected on *Prunus triloba*, the Japan plum, and 207, or about three-fifths, were *Halictus* (*Chloralictus*) *sparsus* Robt., 84 were *Andrena* (*Opandrena*) *bipunctata* Cress., 16 *Trachandrena crataegi* Robt., 10 *Andrena nasoni* Robt., 7 *Halictus* (*Evylaeus*) *arcuatus* Robt., and 5 *H. (E.) truncatus* Robt.

From *Prunus avium* 359 specimens of *Hymenoptera* contained 185 of *Halictus* (*Chloralictus*) *sparsus* Robt., 14 of *C. pilosus* Sm., 15 of *C. zephyrus* Sm., 14 of *Halictus* (*Evylaeus*) *arcuatus* Robt., 15 of *Andrena vicina* Sm., 14 of *A. nasoni* Robt. and 47 of *Andrena* (*Opandrena*) *bipunctata* Cress. There were also 7 specimens of each of three other species of *Halictus*, and 5 of the honey bee, *Apis mellifera* Linn.

Very few insects could be found on peach blossoms, and all that we captured belong to the *Hymenoptera*. Apparently insects do not visit the blossoms in such great numbers and swarm about the trees as is the case with apple, plum and cherry. Of the 12 specimens captured, 3 were *Halictus* (*Chloralictus*) *obscurus* Robt., and there were 2 specimens each of *H. (C.) sparsus* Robt. and *Andrena* (*Opandrena*) *bipunctata* Cress. One honey bee was taken.

Of 197 specimens collected from apple, 34 were *Osmia lignaria*, the commonest species. Honey bees were more abundant than on the other fruit flowers, 31 being taken. The next most abundant species was *Halictus* (*Chloralictus*) *sparsus* Robt., 30 specimens; *Xylocopa virginica* Dru., 15; *Andrena* (*Opandrena*) *bipunctata* Cress., 12; *Halictus* (*Chloralictus*) *zephyrus* Sm., 11; bumble bee, *Bombus consimilis* Cress., 7. Other species, making a total of 32, had each a lesser number of examples.

On pear flowers, 18 out of the 53 *Hymenoptera* specimens were *Andrena nasoni* Robt., 11 *A. (Opandrena) bipunctata* Cress., and there were not over 3 or 4 specimens of any other species. *Halictus* (*Chloralictus*) *sparsus* Robt., which was so abundant on gooseberry, Japan plum, sweet cherry and apple, was not taken at all from pear in 1904, but 3 examples were captured in 1905. No honey bees were taken.

The collection from quince flowers was made at New Haven and Branford wholly in 1905. Of 68 specimens, 18 were *Halictus* (*Chloralictus*) *sparsus* Robt., 9 were *H. fasciatus* Nyl., and of the other kinds not over 6 examples of a species were taken. This included 3 honey bees.

The 18 specimens of *Hymenoptera* from the blackberry contained a single honey bee, and 10 examples of *Andrena* (*Opandrena*) *bipunctata* Cress., which seems to be an important visitor.

The commonest insects collected from red raspberry were *Cerantina dupla* Say. and *Osmia pumila* Cress., 4 each. Not over 2 specimens each were taken of any of the other species, which were 13 in all.

From strawberry flowers 9 specimens were taken, 5 of which were *Halictus* (*Chloralictus*) *versatus* Robt., and 2 were *H. fasciatus* Nyl.

The collections from the flowers of the peach, blackberry, raspberry and strawberry are meager, and perhaps no general statements should be made regarding them. Nevertheless, they indicate the more important pollinating species for the particular localities where taken.

There is no doubt that some of the *Diptera* aid in pollinating the blossoms, for some species are so hairy that if they visit the flowers at all they are certain to carry away some pollen. Such species are *Scatophaga stercoraria* Linn., *Eristalis bastardi* Macq., *Phorbia fusciceps* Zett., and the few specimens representing the genera *Panzeria*, *Tridonta*, *Sarcophaga*, *Fucellia*, *Lucilia* and *Anthomyia*; but except the first and third, these were not sufficiently abundant to be considered as important. It is interesting to note that the commonest flies on these flowers, *Elachiptera costata* Loew., *Ceratopogon fuscus* Coq., *Chlorops assimilis* Macq., *Lonchoptera riparia* Meig. and *L. lutea* Panz., are not hairy, but smooth and shiny and not well fitted to carry pollen. The same is true of the species of *Nemapoda*, *Camptocladus*, *Tachydromia* and *Piophilus* represented in these collections. The few beetles and bugs captured are hardly worth considering as carriers of pollen.

In other localities or in other seasons, the results of such collecting might be quite different. In 1904 there were fewer

honey bees taken than in 1905, yet the small bees were effective pollinators. The trees and bushes bore a heavy crop of fruit. Rainy weather interfered somewhat with the transfer of pollen in 1905, and though the small fruits had a good crop, some of the tree fruits bore lightly.

With our knowledge of the habits of the insects collected, together with the conditions surrounding the localities where they were taken, it seems fair to assume that on account of their great numbers the small bees belonging to the *Halictidae* and the *Andrenidae* are more important agents in carrying pollen than has formerly been supposed, and in the vicinity of New Haven during the seasons of 1904 and 1905 were of far greater benefit in pollinating the flowers of the plants from which they were collected than were the honey bees.

ADDITIONAL MOSQUITO INVESTIGATIONS.

By W. E. BRITTON AND H. L. VIERECK.

In the Report for 1904, page 253, was published an account of the investigations regarding Connecticut mosquitoes and their breeding places. This report treats of mosquito conditions over the entire salt marsh area along the coast, and of the regions about Hartford, East Hartford, Middletown and Cheshire. During 1905 very little attention was given to mosquito work, but a swamp in Milford was visited by request, and the regions about Farmington, New Britain and Rockville were examined by Mr. Viereck in August. The season of 1905 was marked by a shortage in precipitation, especially during the last half of the summer; consequently at the time of Mr. Viereck's visits to these places nearly all pools were dry, and very little mosquito breeding was found.

Milford.

Letters were received regarding the swamp adjoining and just east of the cemetery and north of the railroad. This swamp was visited by Messrs. Britton and Viereck on August 10th, and the pools of the swamp were tested. Both *Anopheles* and *Culex* larvae were found, though not very abundant. The swamp should be cleaned up and drained or filled. The

former would probably be difficult or impossible on account of the topography of the region, but as the area is small, it would not be an expensive matter to fill about the edges, leaving, perhaps, a central pond to be stocked with fish.

While around this swamp we were literally covered with salt marsh mosquitoes (*Culex sollicitans*), which came from their hiding places in the brush of the swamp. These mosquitoes do not breed here, but probably came from the large salt marsh to the south of the village. Improving the swamp near the cemetery would not, therefore, greatly reduce the numbers of mosquitoes in the village, because they come chiefly from the salt marsh. But a place of this kind so near the village and cemetery should be put in the best sanitary condition.

Farmington.

The region between the railroad station and the village was examined August 18th. This area was found nearly free from breeding places, though it comprised a marshy section extending along a primary branch of the Farmington river, and a similar area imperfectly drained by a secondary branch of the same stream. In the latter marsh, tests were made in pools on the property of Mr. A. H. Hopson and in the field adjoining on the side toward the railroad station. *Anopheles* and *Culex* larvae were taken in the last two places mentioned, as many as six *Anopheles* being found in one ladleful of water. These larvae were taken to the laboratory, but *A. punctipennis* was the only species of *Anopheles* reared from the material. For this area better drainage should be provided, and this can be done at small expense.

Though tests were made in nearly all of the suspicious pools, no mosquito larvae were found in the marsh area along the branch of the Farmington river, but as the examination was made after a period of drought, it is quite possible that under other conditions mosquito breeding might occur in this area.

New Britain.

On the eighteenth of August the region about New Britain was examined for possible mosquito-breeding places. The local health officer was consulted, and stated that no com-

plaints had been made about mosquitoes, and that the only possible breeding place of a serious character to be found in the vicinity would be the pond at the foot of Arch Street near the end of the car line. This pond is used for cutting ice in winter, and when examined consisted of little more than a mud flat with a stream running through the center. Near the stream was a small pool in the mud, but no mosquito larvae were found in it. From the appearance of this region it is probably never a serious breeding place.

Rockville.

On August 22d Mr. Viereck visited Rockville, but found not even an area that could be suspected of breeding mosquitoes. Though examined during a period of dry weather, the region seems to be well drained, and the report of the health officer for the past ten years indicates comparative freedom from malaria. The few cases that occur might easily have originated out of town.

Salt Marsh Mosquito at Middletown.

Mr. Walden captured an adult specimen of *Culex sollicitans* at Middletown, July 3d, near the summit of Round Hill. This locality is sixteen or seventeen miles from the coast as the bird flies, and this species of mosquito breeds only in the salt marshes. It is known to migrate inland in search of food, and in New Jersey goes as far as thirty miles, but we have never before taken the species in Connecticut except along the coast.

THE WOOLLY MAPLE LEAF SCALE.

Phenacoccus acericola King.

This insect was first studied at Peoria, Ill., by Miss E. A. Smith, who published an account of the species in the North American Entomologist for 1880, page 73, under the name of *Pseudococcus aceris* Geoff., supposing it to be identical with the European species. In most of the literature this insect has been recorded under that name. On further study it was found to be different from the European species, and was described and named by Mr. George B. King in 1902.*

* Canadian Entomologist, Vol. 34, p. 211.

It is now about five years since I first observed this insect on the maple street trees of New Haven, though the insect may have been present for a much longer time. It has now become quite a serious pest of the sugar maple in Connecticut towns and cities. I have seen it in many places in New Haven, Hartford, Bridgeport and South Norwalk.

On August 2d some maple leaves were sent by a New Haven seed firm with the statement that one of their customers brought them in and asked to know a remedy. The leaves came from a place on Humphrey Street, and were seriously infested with the woolly maple leaf scale. I visited the place immediately, and found a sugar maple of ten or twelve inches in trunk diameter, which was so thoroughly infested that scarcely a leaf was free from the white masses of wax. Many leaves had already dropped. The upper portion of the trunk was completely covered with the larvae. A leaf, showing larvae and waxy egg masses, and a piece of bark from the trunk, showing larvae and male pupae, all from this tree, are reproduced on Plate VII. Two other small trees near by were also infested, though less seriously.

Experiments in Destroying this Pest.

The owner feared that the trees would be killed, and wished to save them if possible. At that time I had not seen any definite advice regarding treatment, and I recommended that the trees be sprayed with ordinary kerosene emulsion. This was done on August 4th, and the mixture contained two gallons kerosene, one half pound common hard soap and one gallon of hot water as a stock solution, this being diluted nine times before using. A few days later I found that a few of the scales had been killed, but that most of them had not been injured by the spray. The owner informed me that the spraying did no good.

These trees were sprayed the second time, August 17th, using an emulsion containing more kerosene and made up with a soft naphtha soap without hot water. Two gallons kerosene, one pound soap, one gallon water, were the quantities used, the whole being diluted five times before applying. This time the trees were very thoroughly drenched, and the spray was directed against the lower sides of the leaves and upon

the bark of the trunk and branches where the larvae were gathered in the crevices. Even with this emulsion containing more kerosene, and with the naphtha soap, it was a somewhat difficult matter to moisten the egg-masses on account of the wax. The first spray striking a leaf rolls off in small drops, but if the nozzle is kept long enough in one place, the mass finally becomes soaked with the emulsion.

A few days after this treatment the trees were examined, and nearly all of the insects appeared to be dead. A few leaves only showed indications of having been injured slightly by the spray.

After making these tests, I ran across Professor Cooley's "Notes on Some Massachusetts *Coccidae*"* in which he states that in the cities of Springfield and Holyoke the authorities have found it necessary to adopt combative measures to control this insect. In Springfield the bark was scraped during the winter and treated with a concentrated whale oil soap solution applied with whitewash brushes. Although this seems to have killed most of the insects, yet at the end of the following summer they had multiplied so rapidly that the treatment was repeated the next winter.

The maples of Holyoke were sprayed with one pound of whale oil soap dissolved in one gallon of water in February, 1896, and for the next two years the insects were not sufficiently abundant to require further treatment.

Unquestionably the best remedial treatment is a winter spray of petroleum, whale oil soap, or some of the contact poisons which can be used in much more concentrated form than can be applied to the foliage. It is difficult to combat this insect with summer sprays. If kerosene emulsion contains much more than 15 per cent. of kerosene, there is danger of injuring the foliage, and if half this percentage of kerosene is employed it will not destroy the scale.

Description, Life History and Habits.

On the under sides of the leaves may be seen masses of white wax about one-fourth of an inch (6 to 7 mm.) in length and somewhat less in width (though varying greatly in size),

* Bureau of Entomology, U. S. Department of Agriculture, Bulletin 17 N. S., p. 61.

having a powdery and woolly appearance. In this mass we find the body of the living or dead female, and a large number of eggs. The adult female is light yellow in color, and is about 5 mm., or one-fifth of an inch long, bearing a number of spinnerets and short spines on the upper surface of the body. The antennae are 9-jointed, the last joint being the longest. The adult male has two wings, and is red in color.

Eggs are found throughout the waxy secretion, and are from 0.3 to 0.4 mm. in length and about half as wide, and light yellow in color.

The larvae when first hatched occupy the under surface of the leaf, though often found on both sides. The female is pale yellow, while the male larva is reddish yellow. When mature the males crawl about over the bark of the branches and trunk, and transform to pupae in the crevices of the rough bark, the adults emerging about two weeks later. The maturing females forsake the leaves and crawl about on the bark, mate with the males, and later return to the leaves and settle upon the under surface. Soon after, the secretion of white wax is commenced, and eggs are deposited in it, both forming a larger mass. Some of this wax often falls or is torn from the leaves by storms, and it adheres to anything coming in contact with it. The number of eggs ranges from 500 upward, and there are three generations each year, according to Dr. L. O. Howard,* who has published one of the most comprehensive accounts of this insect, from which I have gleaned many of the facts set forth in this paper.

At the approach of winter the larvae go to the bark of the branches and trunk, where they line the crevices with their waxy secretion, and remain therein during the winter, crawling about on warm days. They are usually most abundant on the upper portion of the trunk and around the base of the larger branches. The woolly egg-masses and male cocoons are shown on Plate VII.

Natural Enemies.

From material collected, we bred a number of Syrphid flies, and even found some of the larvae feeding upon the scales. Specimens of the adults were submitted to Mr. C. W.

* Insect Life, Vol. VII, p. 235, 1894.

Johnson, of the Boston Society of Natural History, who is a specialist in the *Diptera*, and were identified as *Baccha fascipennis* Wied. This fly is a slender species, with dark bands across the wings. It was sufficiently abundant to warrant us in believing it an important natural enemy of the scale.

The fly, however, was parasitized, and some of the pupae did not yield adult flies, but gave tiny hymenopterous parasites belonging to the genus *Terastichus*. Dr. Howard states that *Baccha fascipennis* Wied. was bred from material sent to him from Jamaica Plains, Mass., and that a species of *Pachyneuron* was reared from the puparium. Three species of lady beetles, *Hyperaspis signata*, *Anatis 15-punctata* and the twice-stabbed lady beetle, are recorded as feeding upon the woolly maple leaf scale in Illinois, and the first was found feeding on the scales received by the Bureau of Entomology from Massachusetts.* All three of these lady beetles occur in Connecticut.

THE WHITE-MARKED TUSSOCK MOTH.

Hemerocampa (Orgyia) leucostigma S. & A.

One of the serious defoliators of shade trees in towns and cities is the white-marked tussock moth, an insect which has done considerable damage during the year of 1905. Early in July I noticed a horsechestnut tree on Elm Street, New Haven, near the corner of York Street, which was being defoliated by the caterpillars, and I sent my assistant to collect material. Mr. Amrhyn, Superintendent of Parks, called upon us to examine an infested tree in Bay View Park, which Mr. Walden did on July 20th. A single chestnut had been wholly stripped of leaves by the caterpillars. The same day elm trees on Orange Street near the corner of Bradley Street were examined by Mr. Walden, attention having been called to these trees by Mr. Frank S. Platt. A large number of cocoons were present on the trunks and larger branches of the trees, and from most of these the moths had emerged. The females were laying eggs, and many white egg-masses could be seen. A photograph of one of the trees with egg-masses on the trunk is shown on Plate VIII. On July 26th, I was called to Hartford to look at some infested trees, and a similar state of affairs was

* Insect Life, Vol. VII, p. 235, 1894.

found. Large elm and poplar trees on North Main Street near the railroad tunnel were so attacked that they had been partially defoliated, and the trunks were literally covered with the cocoons and egg-masses. Egg-masses and cocoons were also received by mail from Hartford.

Later we saw evidences of the work of the insect through the eastern part of the city of New Haven, especially in Grand Avenue and State Street, where a number of elms had been defoliated. The authorities put men at work destroying the egg-masses on some of the worst infested trees along the city streets.

Life History and Habits.

There are two broods each year in Connecticut, and the insect passes the winter in the egg stage. The eggs hatch in May, and the young caterpillars begin to feed upon the under side of the leaves, eating at first only the green portion, and leaving the framework. As the caterpillars increase in size, they eat holes through the leaves, and when nearly full-grown are voracious feeders and devour the whole leaf except perhaps the largest veins. The larval stage lasts about five weeks, during which time the caterpillars molt or cast their skins five times. When nearly mature, the caterpillars have the habit of crawling considerable distances, and are able to go over the ground from one tree to another. Where numerous, they migrate from the defoliated trees, and may be seen crawling over fences, sidewalks or vehicles, and in this way other trees having no egg-masses become attacked.

The larva is very striking and handsome in appearance, of yellow color beneath, with grey stripes along the sides, and a black dorsal stripe between two narrow yellow ones. Along the sides on the grey and yellow stripes are a number of yellow tubercles, each bearing white hairs. Four tufts of white hair are borne on the back of the anterior end of the body, while on the posterior portion in the middle of the black dorsal stripe are two bright red tubercles without hairs. Head and dorsal front portion of first segment are bright coral red. On each side of the head is a pencil or tuft of long black hairs, and a larger tuft occurs on the posterior extremity. The legs and pro-legs are yellow.

The mature larva spins its cocoons about the first week in July, and with the silken threads mixes some of the long hairs of its own body, forming a grey cocoon, which is usually placed on the rough bark of the trunk or larger branches, though sometimes on the small twigs or leaves. The insect

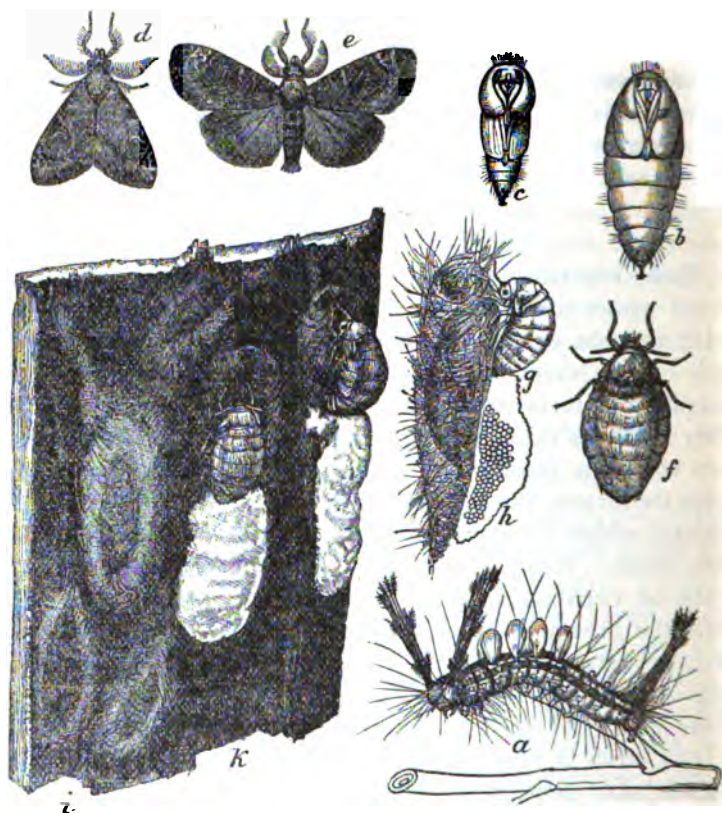


FIG. 1.—White-marked Tussock Moth. *a*, larva; *b*, female pupa; *c*, male pupa; *d*, *e*, male moth; *f*, female moth; *g*, female laying eggs; *h*, egg-mass; *i*, *k*, cocoons—all slightly enlarged. (After Howard, Bur. of Ent., U. S. Dept. of Agr.)

remains in the cocoon nearly two weeks, and as has already been mentioned in this paper, adults had emerged and many egg-masses had been laid on July 20th. The female is without wings, and greatly resembles the females of the canker worms though larger. She is about one-half or five-eighths of an inch long, and grey in color, and usually lays the egg-masses (containing from 75 to 200 eggs) on the empty cocoons. We often see the females hanging in this position on the old

cocoons and egg-masses long after they are dead. The male is a greyish brown moth having feathered antennae, and a wing expanse of about an inch. The adults, caterpillars, cocoons and egg-masses are shown in figure 1, and on Plates VIII and IX.

The eggs laid in July soon hatched, and we fed the caterpillars through August and into September, when they became full-grown and pupated, and adults emerged from some of the cocoons.

Poplars, elms, and soft maples seem to be the trees commonly attacked and injured, but the insect is known to feed upon nearly all kinds of fruit trees, and most of the forest and shade trees except conifers.

Remedies.

There are two chief methods of controlling this insect; (1) by poisoning the foliage, and (2) by destroying the eggs. For spraying, arsenate of lead (about 3 lbs. in 50 gallons of water) is probably the best poison to be used, and it should be sprayed upon the leaves in June in order to destroy the larvae of the first brood. As this poison adheres well to the foliage, it may not be necessary to make more than one thorough application.

The destruction of the eggs is perhaps the most economical method of fighting the pest, and this can be accomplished in two ways: (1) by scraping off and burning the egg-masses, or (2) by treating them on the tree with something that will prevent their hatching. The former method is practiced in New York and some other large cities, where men are employed for the purpose, and become very expert in the use of a specially made tool, consisting of a small hoe blade mounted on the end of a long pole. By means of this tool many of the egg-masses can be reached from the ground and dislodged. If left upon the ground or not destroyed, the eggs will hatch, and they should be burned or treated with creosote oil or something that will prevent hatching. Kirkland advises the use of crude creosote oil for destroying the eggs. A sponge on the end of a long pole is dipped in the liquid and placed against the egg-masses. The oil is rather dark colored, and the white egg-masses are sufficiently discolored by it to show where treated. This was first used for killing gypsy moth

eggs, which are yellowish brown in color, and 15 per cent. of coal tar was added to the oil to color the eggs so that the treated ones could be distinguished from those not treated.

Banding the trunks of unattacked trees will prevent the caterpillars from crawling up, but is of little use if eggs, larvae, or pupae are already in the tree.

THE MORE IMPORTANT COCCIDAE OR SCALE- INSECTS OF CONNECTICUT.*

The terms "scale," "scale-insect" and "bark-louse" are commonly used to designate insects belonging to the family Coccidae of the order Homoptera. The Homoptera are often included in the Hemiptera, to which belong the true bugs, aphids or plant-lice, and leaf-hoppers. These insects all suck their food, and many of them cause serious injury to cultivated plants. The Hemiptera have incomplete transformations, and the Coccidae are probably the most degraded of the Hemiptera. The males are said to have complete transformations, but possess only two wings in the adult state. Soon after birth the young crawl about for a few hours; otherwise the females are without means of locomotion except in a few species, and are attached to the bark or foliage of trees and plants, from which they suck out the sap for food. Some of our worst pests are scale-insects. The object of this paper is to illustrate and describe briefly the more important kinds occurring in Connecticut, so that people will be able to recognize them more readily and combat them more successfully.

As some of these insects secrete a substance which forms a shell or covering for protection, they are called armored scales. Other kinds not forming shells are known as unarmored or soft scales. Most of the unarmored scales secrete honey dew like the plant-lice.

The Latin names and arrangement of the following species are the same as given in Mrs. Fernald's Catalogue of the Coccidae of the World. The illustrations (Plates II-VI) are all original, and show the insects natural size except where otherwise indicated. Plate III, d, is from a drawing. All others are from photographs.

* A part of this paper was published in June as Bulletin 151. With some additions and changes it is here reproduced in different form.

UNARMORED OR SOFT SCALES.

1. **THE GREENHOUSE ORTHEZIA**—*Orthezia insignis* Dougl.

This insect is not fixed, but crawls about like the mealy bugs, and is shown on Plate II, e. Full-grown specimens are about 1.5 mm long. It attacks a great variety of greenhouse plants, Lantana and Coleus being favorites. The treatment used against mealy bugs, page 236, is advised against this insect. All breed continuously in greenhouses, and there are probably many generations each year.

2. **PIT-MAKING OAK SCALE**—*Asterolecanium variolosum* Ratz.

This scale is circular, usually greenish-yellow in color, and has a glassy appearance. It forms a pit or depression in the bark where it is situated, and it is about 2 mm in diameter. (See Plate III, a.) This species has been sent to the Station several times on English oak, *Quercus robur*, though it is known to attack other oaks. Kerosene emulsion and whale oil soap have been used as a spray with good results in destroying this insect.

3. **OAK GALL SCALE**—*Kermes galliformis* Riley.

A globular gall-like scale found on oak twigs. It is grey, about as high as long, and slightly broader than its length, which is about one-fourth of an inch. There is a longitudinal dorsal furrow or constriction. Shown on Plate VI, b.

4. *Kermes andrei* King.

Slightly smaller than the preceding, without constriction, light brown, shiny, with three or four dark brown transverse bands. This scale is also found on oak, but is not very common.

5. **ELM SCALE**—*Gossyparia spuria* Modeer.

A dark-colored oval scale margined by a white cottony fringe is not uncommon upon elm trees about New Haven. It seems to prefer small trees, but is sometimes found on the lower branches of medium-sized and large trees. The insect

is about 3 mm long, brown or black surrounded by a fringe of white wax, and is shown on Plate III, c. The young are born alive, appearing about the middle of June in Connecticut, and settle along the veins of the leaves chiefly on the under sides. Later in the season they return to the larger branches and trunk, and occupy the crevices of the bark, where they remain through the winter. There is but one brood each year. Honey dew is given off profusely by the nearly mature females, and often drips upon the ground. The scales are readily destroyed at any time of the year by spraying with kerosene emulsion or soap and water.

6. WOOLLY MAPLE LEAF SCALE—*Phenacoccus acericola* King.

White powdery masses of wax 6 or 7 mm long are frequently seen on the under side of leaves of the sugar maple. The waxy mass contains the mature female (often dead) and a large number of eggs. This insect is shown on Plate VII, and a full account of it is given on page 226 of this report.

7. COMMON MEALY BUG—*Pseudococcus citri* Risso.

The mealy bug is a common pest of plants in greenhouses and dwellings and even out of doors in summer. Unlike most scales, the mealy bugs are not fixed to their food plants, but are able to move about, and they attack nearly all kinds of plants. The full-grown females are about 4 mm long and oval in shape. They are creamy or dirty white, and covered with a wax secretion which gives them a mealy appearance. They usually congregate in the crotches and at the axils of the leaves so as to be somewhat protected. The illustration, Plate II, d, shows them gathered along the mid-vein of a leaf. Spraying with soap and water or fir tree oil or dipping the plants in the mixture is the remedy, but hydrocyanic acid gas fumigation is doubtless the most satisfactory for greenhouses.

8. LONG SPINED MEALY BUG—*Pseudococcus longispinus* Targ.

Resembles the preceding, except that the adults bear filamentous appendages at the posterior end of the body. The species is well distributed.

9. COTTONY MAPLE SCALE—*Pulvinaria innumerabilis* Rathv.

This scale can be recognized during early summer by the large white egg-masses on the twigs. Nearly all maples as well as many other trees are attacked, but the insect seems to prefer the silver maple. It is not as yet a very serious pest in Connecticut, but in Chicago, Denver, and some other Western cities the maples are being seriously injured by it, and extensive spraying is practiced. There is one annual brood, with eggs laid in May and June, which hatch in July and August. The young first settles on the leaves. The males appear in early fall and mate with the females, which migrate to the twigs, where they remain through the winter. In the spring they increase rapidly in size, and soon deposit their egg-masses and shrivel and die. The brown female with white egg-mass protruding posteriorly is about 12 mm ($\frac{1}{2}$ inch) long, and is shown on Plate III, d. The species is abundantly attacked by insect parasites.

Kerosene emulsion is used as a remedy.

A closely allied species, *P. acericola* Walsh & Riley, is reported from New York and Massachusetts, and doubtless occurs here, but the writer has not observed it. It seems to be confined almost exclusively to the silver maple, and the egg-masses are laid on the leaves instead of the twigs. This requires two migrations,—from the leaves to the twigs in fall, and from twigs to the new leaves in spring. The females with egg-masses are about $\frac{1}{2}$ inch long, the egg-mass tapering backward, with four longitudinal ridges.

10. SOFT SCALE—*Coccus hesperidum* Linn.

Much has been written about this scale, which was formerly placed in the genus *Lecanium*. It is an oval, slightly convex brown species commonly found on citrus trees, oleanders and many other plants in greenhouses. Females are viviparous, but the generations are not well marked. Soap and water or kerosene emulsion will readily destroy these scales at any season of the year.

11. APRICOT SCALE—*Eulecanium armeniacum* Craw.

During recent years this species has become common out of doors in Connecticut, and a wide range of plants are attacked.

We have observed it on plum, grape, chestnut, ash and rose. It is oval in shape, about 4 mm long, strongly convex, and light or dark brown in color. Plate IV, d, gives a good idea of its appearance. This scale is sufficiently abundant to cause considerable injury, and remedial measures must be taken against it. There is one brood annually, the eggs hatch about July 1st, and the scale winters in a partially grown condition. Spraying in winter with kerosene emulsion has been successful, but where orchards are treated with lime and sulphur washes for the San José scale, no other treatment need be given.

12. *Eulecanium canadense* Ckll.

A brown scale on elm twigs, collected in New Haven, June 10th, 1905, by Mr. Walden, proved to be this species. Externally it resembles *E. armeniacum*, and doubtless the same remedy will control it.

13. **NEW YORK PLUM SCALE**—*Eulecanium cerasifex* Fitch.

Plum twigs thoroughly infested with this scale were received from Berlin in 1904. Superficially it looks like *E. armeniacum*, which is shown on Plate IV, d. The writer has made no observations regarding its life history. Where it occurs the same treatment advised for *armeniacum* should be employed.

14. *Eulecanium kingii* Ckll.

A few specimens on sassafras were identified as this species by Mr. Geo. B. King. In appearance it closely resembles the three preceding species.

15. **TERRAPIN SCALE**—*Eulecanium nigrofasciatum* Perg.

The writer has several times collected this scale from the twigs of silver maple, a favorite food plant, which the scale often injures, though it is known to infest fruit and other trees. The females are smaller than in any other species of the genus mentioned in this paper. The adult female is of a reddish color spotted with dark red or black, 2 mm long, convex, with about twelve radiating ridges, most conspicuous near the margin. There is probably one brood each year, eggs being formed in May and hatching in July. (See Plate IV, e.)

16. TULIP SCALE—*Eulecanium tulipiferae* Cook.

This scale is becoming quite common on wild and cultivated tulip trees throughout the state. It is the largest of all the brown scales, the hemispherical females often reaching a diameter of 8 mm, or $\frac{1}{3}$ of an inch. The male scales are much smaller and more elongated. The light grey pupa skins remain on the bark after the adult males have emerged. Both sexes are shown on Plate IV, f. Apparently there is but one brood each year, the viviparous females producing young about September 1st. They are partially grown when winter sets in. As a rule the lower branches are first attacked, and often killed, when those next higher will in turn become infested. Linden and magnolia are also attacked by this scale. Kerosene emulsion, and soap and water applied in the form of a spray, in autumn, are the common remedies.

17. FERN SCALE—*Saissetia filicum* Bdv.

A large brown scale resembling the hemispherical scale, but slightly shorter and more convex, and much less common. It has been an inhabitant of the Station greenhouses, where it seems to prefer the holly shield fern, *Cyrtomium falcatum*.

18. HEMISPHERICAL SCALE—*Saissetia hemisphaerica* Targ.

This is probably the most common of all the large brown scales found in greenhouses and dwellings. It has a long list of food plants, and may be expected to attack almost any kind of plant, but chiefly palms, ferns, *Cycas* and orchids. It is from 3 to 4 mm long, and reddish or dark brown in color. Specimens are found on both leaves and stems. (See Plate III, b.) It probably breeds continuously throughout the year.

Kerosene emulsion, fir tree oil and soap and water can be used as sprays and greenhouses can be fumigated with hydrocyanic acid gas to destroy this insect.

ARMORED SCALES.**19. WHITE ELM SCALE—*Chionaspis americana* Johnson.**

This scale, which attacks the twigs of the elm, closely resembles the scurfy scale, shown on Plate IV, c. It is not very abundant in Connecticut.

20. *Chionaspis corni* Cooley.

The females are pear-shaped, males are small and with sides parallel. Both sexes are white, and closely resemble the scurfy scale, to which the species is closely related. It occurs commonly on wild dogwood, *Cornus candidissima*. The life history is probably similar to that of the scurfy scale.

21. **EUONYMUS SCALE**—*Chionaspis euonymi* Comst.

This species was recently sent to the writer from Hartford, where it was abundant on *Euonymus radicans* along a brick wall. The wall was covered with canvas, and the plants fumigated with hydrocyanic gas.

The euonymus scale resembles the scurfy scale, but the females are somewhat smaller and darker in color. It passes the winter in the egg stage, and the different species of *Euonymus* and the orange are attacked. It is shown on Plate II, b.

22. **SCURFY SCALE**—*Chionaspis furfura* Fitch.

The female shell is broadly pyriform, 3 mm in length, and white or light grey. See Plate IV, c. The male is much smaller, white, with sides parallel, and three ridges along the back. A single brood is formed each year, and the winter is passed in the egg stage. These eggs are oval in shape, purple in color, and hatch between May 20th and June 1st. Spraying with soap and water or kerosene emulsion soon after the eggs hatch will readily destroy the young. For a more complete history of this insect the reader is referred to Bulletin No. 143, or the Report of this Station for 1903, page 227.

23. **PINE LEAF SCALE**—*Chionaspis pinifoliae* Fitch.

Resembles the preceding, but is attached to the leaves or "needles" of the pine, spruce and other coniferous trees. It has been collected at South Manchester on *Pinus mughus* and at Hartford on white pine. There are two broods each year, and the winter is passed in the egg stage. See Plate II, c.

24. *Diaspis boisduvalii* Sign.

This scale, found on palms and various greenhouse plants, resembles the rose scale. The female is large, nearly circular,

with the exuvium not in the center. The male is long and narrow, and both sexes are nearly white.

25. ROSE SCALE—*Aulacaspis rosae* Bouché.

A large white scale is sometimes seen on rosebushes, raspberry or blackberry canes, especially where growing in crowded rows or clumps. The female is nearly circular, 2.5 mm in diameter, and is shown on Plate V, a. The male is much smaller, long and narrow, with three parallel ridges running lengthwise of the shell. Professor John B. Smith of New Jersey finds that all stages from the egg to the mature female occur at the same time during the winter and throughout the season. Probably there are but three complete broods, but these overlap so that breeding is almost continuous.

As all stages of the insect occur at the same time remedial treatment is somewhat difficult, as the eggs are usually not killed by sprays, and sometimes survive even fumigation. The worst infested canes should be cut out and burned. Kerosene emulsion or soap and water should be used as a summer spray, and the lime and sulphur mixture may be applied to the dormant plants in winter.

26. *Epidaspis piricola* Del Guer.

A circular scale occurring under the edges of rough bark, and covered with extraneous matter so as to be very inconspicuous. Found on pear twigs from New London.

27. HEMLOCK LEAF SCALE—*Aspidiotus abietis* Schr.

This species was found on hemlock at Norwalk. It is a small circular or elongated brown scale, and is sometimes found upon pine or fir.

28. PUTNAM'S SCALE—*Aspidiotus ancylus* Putnam.

This is a small circular scale, 2 mm in diameter, which occurs throughout the state on fruit trees, but perhaps most frequently upon currants, often killing the second year canes or shoots. The shells of this scale are usually not as nearly circular as the San José scale, but it is often difficult to distinguish them in the field. Apparently there is but one brood each year.

29. *Aspidiotus cyanophylli* Sign.

This is a small light colored circular scale often found infesting palms and orchids in greenhouses. Specimens in the Station collection were taken at New Haven, January 9th, 1904.

30. **CHERRY SCALE**—*Aspidiotus forbesi* Johnson.

This scale closely resembles the preceding, and though not so widely distributed, has been found upon fruit trees in Connecticut. It should be regarded as a serious enemy, and treated in the same way as the San José scale.

31. **WHITE SCALE; OLEANDER SCALE**—*Aspidiotus hederæ* Vall.

This scale is a pest of greenhouses, where it attacks oleander, croton, ivy, palms, camellia and many other plants. It is nearly circular in shape, and white or light grey in color, making it conspicuous on the green leaves and stems. (See Plate II, a.) It probably breeds continuously in greenhouses. Fumigating the house with hydrocyanic acid gas, spraying the infested plants with either whale oil or common soap (1 lb. in 8 gallons of water) are the remedies for this scale.

32. **EUROPEAN FRUIT SCALE**—*Aspidiotus ostraeformis* Curtis.

This scale is not known to be established in Connecticut, but will doubtless become so, as it has been found on nursery trees sent into the state. It looks very much like the cherry, Putnam's, and San José scales, and can be distinguished from them only by means of the compound microscope. In fact these four species resemble each other so closely that the fruit grower cannot distinguish between them unless he is an entomologist. The European fruit scale attacks all kinds of orchard trees, and there is probably a single brood each year.

33. **SAN JOSE SCALE**—*Aspidiotus perniciosus* Comst.

This is a circular scale, light or dark grey in color, with concentric markings and a nipple in the center, which is usually darker in color than the surrounding portion of the shell. The winter is passed in a half-grown condition, and there are no

eggs. The breeding season begins soon after June 20 and ends about December 1 in Connecticut, three or four broods appearing in a season. For a full account of its life history and spread, see Bulletin No. 135 of this Station.

This scale is the worst pest of the fruit grower in Connecticut, and attacks all kinds of fruit trees, except the sour cherry (*Prunus cerasus*), and many kinds of shade trees and ornamental shrubs are attacked and sometimes killed. A list of trees and plants, showing their susceptibility to attack by this scale, was published in the Report of this Station for 1902, page 130. A thorough spraying in the fall after the leaves drop, or in the spring just before the buds start, using a lime and sulphur mixture, seems to be the best remedy for Connecticut. This mixture is usually prepared by boiling together 20 pounds quicklime and 14 pounds sulphur for 45 to 60 minutes in enough water to keep it a liquid. After boiling, water should be added to make 40 gallons, and the whole applied at once. Satisfactory mixtures can be made without boiling by using potassium or sodium sulphide, caustic soda or sal soda to aid in dissolving the sulphur. Some of these mixtures and the proper outfit for spraying are described in Bulletin No. 146, and reproduced in the Report of this Station for 1904, pages 240-252.

The illustration of the San José scale on Plate IV, a, will serve to show the appearance of the other kinds which so closely resemble it. All can be combated in the same way, viz: by spraying the dormant orchard trees with the lime and sulphur mixture, and by fumigating nursery stock with hydrocyanic acid gas.

34. **ELM ASPIDIOTUS**—*Aspidiotus ulmi* Johnson.

This is a small circular scale resembling the preceding, which is found on the smooth or inner bark in the crevices of the rough bark of the trunks and larger branches of elm trees. It seems to do very little damage, but may be found on most of the elm trees of New Haven, and doubtless occurs throughout the state.

35. **CIRCULAR SCALE: FIG SCALE**—*Chrysomphalus aonidum* Linn. (*figus* Ash.).

Rubber plant, orange, palms, camellias and oleander in greenhouses are often infested by a round dark-colored scale

which stands out prominently from the surface of the leaves. In fact it is almost conical in shape, reddish brown or nearly black, with an orange apex, and is shown on Plate V, b. Presumably it continues to breed throughout the year under glass, and continued spraying is necessary to keep it in check.

36. **RED ORANGE SCALE**—*Chrysomphalus aurantii* Mask.

A light grey or brown circular scale about 2 mm in diameter occurring on oranges and lemons in the markets and sometimes infesting citrus trees and palms in greenhouses. The scale is somewhat translucent, showing the reddish insect beneath. The female is reniform in shape. This scale causes much injury in the orange groves of California, and also occurs in Florida.

37. **MORGAN'S SCALE**—*Chrysomphalus dictyospermi* Morg.

This species is a serious pest of palms at Pierson's large commercial greenhouses, Cromwell, and it has also been taken in private plant houses in other parts of the state. It is of about the same color as the preceding species, but is flatter, and projects only slightly from the leaf. Mr. H. E. Hodgkiss studied this scale at the Massachusetts Agricultural College, and found that several generations are produced each year, but these overlap so as to become indistinct. The females bring forth living young, are parthenogenetic, and males are unknown. Fumigating the house with hydrocyanic acid gas, using 7.5 grams potassium cyanide for each 100 cubic feet of space, for forty minutes, after dark, with the plants free from moisture, is the treatment advised by Mr. Hodgkiss after making many experiments. It is probably a safe remedy for nearly all of the greenhouse scales. This species is shown on Plate VI, a.

38. **PURPLE SCALE**—*Lepidosaphes beckii* Newn.
(formerly known as *Mytilaspis citricola* Packard).

An elongated scale very commonly noticed on oranges and lemons in the markets. It has been sent to the station by correspondents, who took it to be the San José scale. It resembles the oyster shell scale, to which it is closely related, and is said to be one of the commonest orange scales in Florida. It is also found in California.

39. OYSTER SHELL SCALE—*Lepidosaphes ulmi* Linn.(formerly *Mytilaspis pomorum* Bouché).

One of the most common and widely distributed of all coccids. It is a pest of fruit trees, especially apple, and many young sprouts and seedlings of birch, poplar, willow, ash and butternut are killed by it each year. Lilac is also infested. There is but one brood annually, and the insect winters in the form of oval white eggs under the female shells. The eggs hatch in Connecticut about the first of June, the young crawl for a few hours, then settle upon the bark and form shells, becoming mature in September. Eggs are laid about the first of October, and the females die. The female scale (or shell), is from 2 to 3 mm long, about the same color as the bark upon which it rests, elongated pyriform in shape, and more or less curved. It is shown on Plate IV, b. Male shells are much smaller and less curved than those of the female. The adult male has two wings, and is seldom seen. Spraying with kerosene emulsion or soap and water soon after the eggs hatch will hold this scale in check. For a more complete account see Bulletin 143, or the Report of this Station for 1903, page 229.

40. THREAD SCALE—*Ischnaspis longirostris* Sign.

This is a long narrow black scale attacking palms, pandanus and many other plants in greenhouses. It has been taken in Connecticut only at one greenhouse in New Haven, where it was quite abundant. Little is known of its life history, and the male is unknown. The female shell is from 2 to 3 mm long, and about eight times as long as broad, and more or less curved. (See Plate V, c.) The writer has had no experience in combating this scale, but the same treatment used for other greenhouse scales will doubtless hold it in check.

41. CHAFF SCALE—*Parlatoria pergandii* Comst.

This is common on various greenhouse plants, especially orange and lemon. It is oval in shape, with the molted skin at one end, and is light yellow in color. It is usually found in clusters. The common sprays used for greenhouse scales seem to be effective against this species.

THE GYPSY MOTH IN CONNECTICUT.

Ever since the gypsy moth became prevalent in Massachusetts it has seemed probable that the pest might at any time invade Connecticut. We have therefore been on the watch for it, though no systematic inspection has been made of the regions where the pest would be most liable to occur. Several times during the past five years reports of the presence in Connecticut of the gypsy moth or the brown tail moth have been brought to my attention, but investigation proved that some other insect was the cause of alarm in each case.

In compiling a list of Connecticut insects during the winter, I have corresponded with local collectors whose names appear in the Entomologists' Directory, in order to obtain records of their captures. On February 27th I received a letter from Mr. Ernst Frensch of Mystic, a collector of Lepidoptera, with records of some of the rarer species which he had taken, and this list included *Porthetria dispar* Linn., the gypsy moth. Mr. Frensch closed his letter with this sentence;—"Probably it will be new to you that *Porthetria dispar* has reached the town of Stonington."

I wrote at once, making an appointment with Mr. Frensch, and visited him at his home Tuesday, March 6th. He showed me a female which he had found on an apple tree in the yard of his brother, Karl Frensch, near the railroad, and not far from the velvet mill in Stonington. This specimen was taken July 30th, 1905, and is now in the Station collection. The attention of Mr. Frensch was first attracted by two males flying about in the tree, but as he did not have a net he could not catch them. On looking closer he found the female resting on the bark, and he put her in his cyanide jar. I was shown an egg-mass on the under side at the base of a large branch of a Norway maple growing in the yard. This was removed, and later put in a cyanide bottle to kill the eggs. Mr. Frensch also showed me an egg-mass which he found on a small twig in the brush-covered area close to the velvet mill. He suspected these to be gypsy moth eggs, but to make sure, he cut off the body of the female moth, and obtaining the eggs therein, compared them with those on the twig, and found them identical in size, shape and general appearance.

Mr. Karl Frensch also collected one female gypsy moth during the summer, and this was still in his cyanide jar at the time of my visit. The Frensch brothers have both collected insects, and Ernst has a good collection of butterflies and moths. He recognized the gypsy moth because he had been familiar with it in Germany.

On March 11th I again visited the place in company with my assistant, Mr. B. H. Walden, and we looked about the trees in the yard where the specimens were taken, but found no more fresh egg-masses. I found an old egg-mass on a pear tree in the adjoining yard. The eggs undoubtedly hatched last spring, and may have been the source of the entire infestation. I had telephoned on my arrival to Col. James F. Brown of North Stonington, Secretary of the State Board of Agriculture, and he joined us in the afternoon. In company with Mr. Karl Frensch we examined the brush-covered area just north of and close by the velvet mill. Here we found seven fresh egg-masses, which were immediately placed in cyanide bottles to kill the eggs. Rain and lack of time prevented an inspection of the whole area. As we passed through the streets of the village we watched for egg-masses on the trunks of the trees. Tussock moth eggs were abundant, but we did not see any gypsy moth eggs.

At the time of writing this report, the infested region seems to be a small one, restricted to the immediate vicinity of the velvet mill, but is being examined by a trained inspector who has had a long experience in this work in Massachusetts. Every effort will be made to stamp out the pest, and this may be possible if the insect has not already spread over a large area.

Outbreak and Distribution.

An outbreak of the gypsy moth in Eastern Massachusetts was met by an appropriation by the Legislature of that state for the purpose of suppressing the insect. Exterminative work was commenced in 1890 and kept up for ten years, when it was discontinued. During this period over \$1,000,000 was expended and the insect was so far checked that it was doing little damage in 1900. In 1905 the pest had spread over so much territory and had become so troublesome that the commonwealth again took the matter in hand, and is endeavoring

to control the insect under the superintendence of Mr. A. H. Kirkland, an appropriation of \$300,000 being available to carry on the work until May, 1907.

At the present time the insect is found throughout the eastern portion of Massachusetts, southeastern New Hampshire, and a region in and about Providence, R. I., is known to have been infested for two years or more. It has recently been found in Stonington, Connecticut.

Life History and Injury.

The eggs are laid usually on the trunks and branches of trees, but sometimes on fences, buildings, etc., in July and August, in oval masses each containing about 500 eggs and covered with hair as shown in Figure 2 and on Plate X.



FIG. 2. Egg-mass of Gypsy moth on bark, natural size.

The eggs hatch about May 1st, and the young caterpillars soon begin to feed upon the expanding foliage, devouring all kinds of vegetation, even defoliating coniferous trees. All the damage is done in this stage. As the caterpillars approach maturity, they feed mostly at night, and seek shelter during the day on the shady side of the trunks, under fence rails, stones and rubbish, where they may often be found in large numbers.

When full-grown, the caterpillar is between two and three inches long, dark brown, with a pair of blue spots on each of the first five segments, and the same number of red spots on

each of the other six segments, making two rows of spots along the back; it is covered with long hairs, as is shown in Figure 3. The caterpillar usually reaches full size in July, and transforms to a pupa or chrysalis, usually spinning a few threads about itself, and is shown in Figure 4 and on Plate X.

During the latter half of July the adult moths emerge, mate, and the females lay eggs. The brown male has a wing expanse of one and one-half inches, and flies about in the daytime in



FIG. 3. Gypsy caterpillar, natural size.



FIG. 4. Chrysalis or pupa of Gypsy moth. Natural size.

a zigzag course. The female has a heavy body, and does not fly far, though furnished with wings which expand about two inches, and which are nearly white, with delicate black markings. See Figure 5. The male is shown in Figure 6. There is but one brood each season.

Means of Distribution.

As the caterpillars crawl about in going from one tree to another, they are very apt to invade freight cars on the siding, and be carried to other places. When young they have the habit of spinning down on slender threads from their food, trees, and may thus drop on carriages, automobiles or railroad

cars, and be carried long distances into a part of the country heretofore uninfested.

Natural Enemies.

There are several species of parasitic Hymenoptera, Diptera and predaceous insects that attack both the gypsy and brown-tail moths in Massachusetts, and they are also devoured by birds, toads, and other insectivorous animals. But all of these working together do not control the pests.

Importation of Parasites.

In Europe, the native home of these insects, there are a larger number of parasitic enemies belonging to species not



FIG. 5. Female Gypsy moth, natural size.

found in this country. During 1905, Dr. L. O. Howard, the Government Entomologist, in coöperation with the Massachusetts authorities, collected in Europe some of the parasites of the gypsy and brown-tail moths, and sent them to Massachusetts, where they will be reared and finally distributed in the infested region. Of course these parasites may not be able to thrive, or even to live, in this country, but it is an experiment worth trying, and we certainly hope for much benefit from it.

Remedial Measures.

One of the most effective means of controlling the gypsy moth is by destroying the egg-masses on the trunks and branches of trees, on fences, stones, or wherever they occur. A sponge, brush or swab is dipped in creosote mixture, and the egg-masses are saturated with it. A long pole can be

used to reach the egg-masses, but it is often necessary for men to climb about in the trees in order to reach them. Where brush land is badly infested, it is often best to cut and burn the brush between August and May to destroy the eggs. Spraying the foliage with arsenate of lead, using 5 pounds to 50 gallons of water, will of course save the trees from injury for the season. This poison adheres to the tree for a long time, and will not injure the leaves. Paris green can be used at the rate of one pound in 100 gallons of water, but two pounds of lime should be added to prevent injury to the foliage. This mixture will not adhere to the leaves as well as arsenate of lead.

The caterpillars can be gathered and destroyed while resting on the tree trunks or hiding under rubbish during the day. The chrysalids or pupae will be found in similar places, and can also be destroyed by heat or by crushing.



FIG. 6. Male Gypsy moth,
natural size.

Coöperation Desired.

It is earnestly requested that any suspected eggs, caterpillars or adults be called to the attention of the State Entomologist, in order that he may identify them. He will investigate any locality suspected of being infested with either the gypsy or brown-tail moths, and every possible means will be taken to eradicate them if found. This is a matter so serious as to be exceedingly important, and the coöperation of every one is needed and desired.

DO NOT SEND LIVING INSECTS.

It is against the United States laws to send living insects by mail, and violations of the law are punishable by a heavy fine and imprisonment. Moreover it would be dangerous to send such pests as the gypsy or brown-tail moths in any stage of their existence, if alive.

All insect specimens should therefore be killed before sending them to be identified.

Eggs, pupæ and larvæ can be killed by dropping them into a jar of alcohol, benzine or gasoline and leaving them for a few hours. When removed the liquid evaporates and they are in good shape for identification. Beetles, bugs and scale insects can be treated in the same way. Moths and butterflies may be killed by the fumes of cyanide, chloroform, ether, carbon bisulphide, or they may be submerged in gasoline or benzine, which kills them quickly without injuring them for the purpose of identification. They should be packed in a tin, wood or strong paste-board box which will not be crushed in transit.

RAVAGES OF THE INDIAN MEAL MOTH IN A SEED WAREHOUSE.

In November I learned that one of the large seed warehouses of Connecticut was infested with some insect that was causing considerable damage to corn, peas, lettuce and other seeds stored there. The place was visited November 17th, and the Indian meal moth, *Plodia interpunctella* Hubn., was found to be responsible for most of the damage. A few larvae of the cadelle, *Tenebroides mauritanicus* Linn., were also present, feeding in the bags of corn.

The seeds had been cleaned and stored in bags, and corn was more seriously infested than other seeds. Larvæ were very abundant on the outside of some of the bags, where they had made a covering of their webs, which could be peeled off in large sheets. One of these webs with larvæ is shown on Plate XI, b. The kernels of corn next to the bag were infested as shown in the illustration on Plate XI, a, but these were fastened to the bag by the web so that on emptying a bag several pounds of corn adhered to the bag. Some larvæ were found in the center of the bag, but most of them were near the outside.

One room, partitioned off in the storehouse, seemed to be fairly tight, measured 16 × 30 feet and 9 feet high and contained 4,320 cubic feet. Some of the worst infested bags of corn were moved into this room, which was fumigated with hydrocyanic acid gas. Materials used were as follows:

Potassium cyanide	2¾ lbs.
Sulphuric acid	5½ "
Water	11 " (5½ qts.)

The acid was placed in a stone china wash bowl, and properly diluted with the water. About 5 P. M. the cyanide was added and the room closed and remained so until November 20th, when it was opened up and aired. At first the owner thought that all of the larvae were dead. After a few hours, however, larvae were crawling about on the outside of the bags, having emerged from within, where the gas did not reach them. The webs on the outside of the bags doubtless prevented the gas from penetrating the bags, though it is doubtful if this gas would penetrate the grain to any great distance if the webs were absent.

The Indian meal moth is often a pest of dwellings, stores and warehouses, feeding upon all kinds of vegetable foods and products, and breeding throughout the year in heated

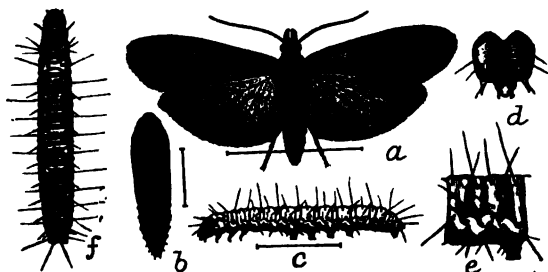


FIG. 7. Indian meal moth. *a*, adult; *b*, pupa; *c*, larva, side view; *d*, head of larva, front view; *e*, first abdominal segment of larva; *f*, larva, dorsal view—all greatly enlarged. (After Chittenden, Bur. of Ent., U. S. Dept. of Agriculture.)

buildings. From four to five weeks are required for the production of a brood. The eggs are small and white, and are laid in groups, each group containing from three to twelve eggs. As many as 350 may be laid by a single female. The caterpillars as they feed and travel spin a silken thread joining together the particles of food and their excrement. This habit renders worthless considerable material which, though infested, has not been devoured by them. They transform to chrysalids in small silken cocoon-like webs, and from these the adult moths emerge. The moth is light brown, with the outer half of each front wing dark brown. It has a wing-spread of from one-half to three-fourths of an inch. It is closely related to the common clothes moth, which it resembles except

that it is much darker in color. The larva, pupa and adult are shown in Figure 7.

The best and cheapest remedial treatment is to place the loose seeds or grain in a tight bin and fumigate with carbon bisulphide, using about one pound of the liquid for each one hundred bushels, and placing it in a shallow dish on the top of the grain. It vaporizes quickly, and being a heavy gas, penetrates readily to the bottom of the bin. No fire should be brought where bisulphide is used, for the vapor is very explosive.

IDENTIFICATION OF INSECTS.

The identification of insects for correspondents, fruit growers, farmers, and others, is increasing each year, and considerable time is required for this work. In addition to the regular work of this sort, the entomologist's office has rendered aid in determining species collected in Branford by Rev. H. W. Winkley. Mr. Winkley has taken an interest in collecting insects, and has furnished us much valuable material for our collection. He is now preparing a local collection of species found in Branford, to be placed in the beautiful library in that village, and we in turn have helped him to classify his specimens.

Aside from Mr. Winkley's material, 174 samples have been received for identification during the year. For the determination of some of the species I am indebted to the Bureau of Entomology at Washington. A classified list of those which could be determined is here given.

INSECTS RECEIVED FOR IDENTIFICATION DURING 1905.

ORTHOPTERA.		
<i>Ischnoptera pennsylvanica</i> DeG.	Cockroach	Mt. Carmel.
<i>Sphargemon saxatile</i> Morse.		Mt. Carmel.
<i>Scudderia curvicauda</i> DeG.		Hartford.
<i>Cemophorus grandis</i> Scudd.	Camel Cricket	Mt. Carmel.
HEMIPTERA.		
<i>Hamatopinus vituli</i> Linn.	Long-nosed ox louse	Lower Canada.
<i>Cicada canicularis</i> Hart.		New Haven.
<i>Enchenopa binotata</i> Say.		Middletown.
<i>Phylloxera vastatrix</i> Planch.	Grape phylloxera	Noroton.
<i>Chermaphis abietis</i> Linn.	Spruce gall louse	New Haven.
<i>Pemphigus acerfolii</i> Riley.		Hartford.
<i>Schizoneura americana</i> Riley		Hartford.
<i>Schizoneura pinicola</i> Thos.		Middletown.
<i>Schizoneura</i> sp.		Greenwich.
<i>Lachnus strobil</i> (?) Fitch		Waterbury.
<i>Callipterus betulae</i> Fitch		Hartford.
<i>Aphis gossypii</i> Glover (?)		Suffield.
<i>Aphis pomi</i> DeG.	3 samples	Farmington, Middletown, Guilford.
<i>Myzus rosarum</i> Walker (?)		Simsbury.
<i>Noctiarophora rudbeckiae</i> Fitch		Concord, Mass.
<i>Aleyrodes vaporariorum</i> Westw.	White fly, 2 samples	New Haven, Hartford.
<i>Orthetia insignis</i> Dougl.	The greenhouse orthezia	Hartford.
<i>Asterolecanium pustulans</i> Ckll.		Nicaragua.
<i>Leaniodiadipis rugosus</i> Hemp. (?)		Nicaragua.
<i>Phenacoccus acericola</i> King	Woolly maple leaf scale, 3 samples	New Haven, Westport.
<i>Puleinaria innummabilis</i> Rathv.	Cottony maple scale	Norwich.
<i>Puleinaria</i> sp.		Black Hall.
<i>Eulecanium</i> probably <i>armeniaceum</i> Craw.	Apricot scale, 3 samples	New Haven, Stamford.
<i>Eulecanium nigrofasciatum</i> Perg	Terrapin scale	Forestville.
<i>Eulecanium tulipiferae</i> Cook		Columbia.

INSECTS RECEIVED FOR IDENTIFICATION DURING 1905—Continued.

<i>Chionaspis euonymi</i> Comst.	Euonymus scale	Hartford.
<i>Chionaspis furfura</i> Fitch	Scurfy scale, 11 samples	From Woodbridge, Danbury, Brooklyn, Enfield, Newington, South Coventry, Montowese, New Haven, Norfolk, Meriden, Clinton.
<i>Chionaspis pinifoliae</i> Fitch	Pine leaf scale	Hartford.
<i>Aulacaspis rosae</i>	Rose scale, 2 samples	From Yalesville, Simsbury.
<i>Aspidiotus hederæ</i> Vallot	White, or oleander scale	Hartford.
<i>Aspidiotus perniciosus</i> Comst.	San José scale, 31 samples	From New Haven, Greenwich, Farmington, Rockville, Branford, Woodbridge, Hartford, Stamford, Seymour, Danbury, North Stonington; West Dover, Ohio; Bridgeport, Lyme, Montowese, Meriden, Union City, Southport.
<i>Lepidosaphes ulmi</i> Linn.	Oyster shell scale, 11 samples	From Lyme, Woodbridge, Branford, Guilford, Danbury, North Sterling, New Haven, Montowese, Bethlehem.
<i>Euichistus variolarius</i> Beauv.	Rose scale	Southington.
<i>Lopidea confusus</i> Say.	New Haven.	
<i>Calocoris rapidi</i> Say.	Bridgeport.	
<i>Lygus pratensis</i> Linn.	Tarnished plant bug	Bridgeport.
<i>Poecilopapsus lineatus</i> Fab.	Four-lined leaf bug	Westport.
<i>Belostomatia americana</i> Leidy	2 samples	New Haven, Greenwich.
NEUROPTERA.		
<i>Corydalus cornutus</i> Linn.	Heilgrammite	Canada.
<i>Chrysopa oculata</i> Say.	Lace wing	Bridgeport.
<i>Colobopterus exilis</i> Hagen		Savin Rock.
LEPIDOPTERA.		
<i>Tineola bisellitella</i> Hummel.	Clothes moth	New Haven.
<i>Lithocolletes hamadryella</i> Clem.	Oak leaf miner	Hartford.
<i>Bucculatrix pomifoliella</i> Clem.	Apple bucculatrix	Meriden.
<i>Plodia interpunctella</i> Hubn.	Indian meal moth	Canada.

INSECTS RECEIVED FOR IDENTIFICATION DURING 1905 — *Continued.*

<i>Prionoxystus robiniae</i> Peck	Carpenter worm	South Manchester.
<i>Phobetrus pilicinctus</i> S. & A.	Hag moth	New Haven.
<i>Sibine stimulea</i> Clem.	Saddle-back caterpillar	Bridgeport.
<i>Hamocampa leucostigma</i> S. & A.	White-marked tussock moth	Hartford.
<i>Schistura concinna</i> S. & A.	Red-humped caterpillar	Hartford.
<i>Datana integrissima</i> G. & R.	Walnut caterpillar	Middletown.
<i>Datana ministra</i> Drury	Yellow-necked caterpillar	New Haven.
<i>Metatopia inclusa</i> Hubn.		Greenwich.
<i>Apanteles torrefactus</i> S. & A.		New Haven.
<i>Tarache erastroides</i> Guen.		Bridgeport.
<i>Euthianotia</i> sp. (?)		Boston, Mass.
<i>Papaipemia nitela</i> Guen.	Stalk borer	Branford.
<i>Heliophila pseudargyria</i> Guen.	False army worm	New Haven.
<i>Mamestra picta</i> Harr.	Zebra caterpillar, 2 samples	Whigville, New Haven.
<i>Diactris virginica</i> Fabr.	Virgin moth	New Haven.
<i>Hyphantria cunea</i> Dru.	Fall webworm	Hartford.
<i>Epantheria difformata</i> Fabr.	Great leopard moth	New Haven.
<i>Anisota sratatoria</i> S. & A.	Senator moth; Orange-striped oak worm	New Haven, Hartford.
<i>Telea polyphemus</i> Cram.	American silk worm, 2 samples	Westville.
<i>Samia cecropia</i> Linn.	Cecropia moth, 2 samples	West Hartford, Bridgeport
<i>Ceratonia undulosa</i> Walk.	Mourning cloak butterfly; spiny elm caterpillar	Hartford.
<i>Vanessa antiopa</i> Linn.		Phoenixville.
Diptera.		
<i>Chironomus</i> sp.		New Haven.
<i>Lasioptera vitis</i> O. S.		New Haven.
<i>Tabanus atratus</i> Forst.	Black horse fly	Hartford.
Siphonaptera.		
<i>Pulex serraticeps</i>	Cat and dog flea	Oakville.

INSECTS RECEIVED FOR IDENTIFICATION DURING 1905—*Concluded.*

COLEOPTERA.

<i>Scolytus rugulosus</i> Ratz.	Fruit bark beetle.....	Wilton.
<i>Xyleborus caelatus</i> Eich	.....	North Carolina.
<i>Pissodes strobi</i> Peck	White pine weevil.....	New Haven.
<i>Epicauta vittata</i> Fabr.	Striped blister beetle.....	Shelton.
<i>Coptoclycla aurichalcea</i> Fabr.	Gold beetle.....	Boston, Mass.
<i>Epitrix cucumeris</i> Harr.	Cucumber flea beetle.....	Bridgeport.
<i>Galerucella luteola</i> Müll.	Elm leaf beetle.....	New Haven.
<i>Saperda candida</i> Fabr.	Round-headed apple borer.....	Yalesville.
<i>Prionus laticollis</i> Dru.	Broad-necked Prionus.....	New Haven.
<i>Orthosoma brunneum</i> Forst.	Lesser Prionus.....	South Manchester.
<i>Parandra brunea</i> Fabr.	.....	South Manchester.
<i>Osmoderma scabra</i> Beauv.	.....	Hartford.
<i>Lachnosterna fraterna</i> Harr.	June beetle.....	Hartford.
<i>Macrodactylus subspinosus</i> Fabr.	Rose chafer.....	Westport.
<i>Lastoderma testaceum</i> Duft.	Cigarette beetle, 2 samples.....	New Haven.
<i>Phengodes laticollis</i> Lec. (?)	.....	Salem.
<i>Byturus unicolor</i> Say.	.....	Mystic.
<i>Chilocorus bivulnerus</i> Muls.	Twice-stabbed lady beetle, 3 samples.....	Farmington, South Coventry, Waterbury.
<i>Adalia bipunctata</i> Linn.	Two-spotted lady beetle.....	Westville.
<i>Necrophorus americana</i> Oliv.	.....	Hartford.
<i>Pterostichus lucublandus</i> Say.	.....	Newington.

HYMENOPTERA.

<i>Emphytus canadensis</i> Kby.	Violet saw fly.....	Westville.
<i>Harphorus maculatus</i> Norton.	Strawberry saw fly.....	Cromwell.
<i>Eriocampoides cerarii</i> Peck	Cherry saw fly.....	Hartford.
<i>Camponotus pennsylvanicus</i> DeGeer	Carpenter ant.....	West Cromwell.
<i>Vespa crabro</i> Linn.	European giant hornet.....	New Haven.

NOTES.

Rose Chafer Injuring Peaches. The common rose chafer, *Macrodactylus subspinosus* Fabr., was very abundant in June, and attacked various kinds of plants. On June 16th, some young peaches about one-third grown were received from Norwich with the statement that they were injured by the rose chafer. Some of the fruits had holes eaten into them, and others were perhaps half eaten up, and are shown on Plate XII, b. The correspondent wrote that in some cases he saw "five or six of the beetles eating at one opening with heads close together, and with bodies radiating out from this comparatively small hole." He was afraid that the crop would be entirely ruined, and had the beetles picked by hand and dropped into a pail of hot water. Nearly two hundred were gathered from about forty trees.

In my own garden, rose chafers were very troublesome on peony blossoms, many fine flowers being spoiled soon after they opened. The beetles devour the petals, and on the white varieties they were more serious than on pink or red flowers because their work was more apparent, as they ate a portion of each flower and soiled the remaining portion, thus spoiling it. My only remedy was to keep a tomato can partially filled with kerosene in the garden, and whenever I saw a beetle on a flower I caught him and dropped him into the kerosene. This is a good way to manage with aster beetles in a small garden.

Lily of the Valley Attacked by a Beetle. On May 15th we noticed that the leaves of lily of the valley plants growing in the garden had been eaten in a peculiar manner. Notches had been eaten into the edges of the leaves, as is shown on Plate VI, d. A number of curculionid beetles were captured while at work on the leaves, and there is no doubt that they were responsible for the injury. Some plants were placed in the insectary, where the beetles continued to feed upon them. Through the kindness of Dr. L. O. Howard, this insect was identified at the Bureau of Entomology as *Hormorus undulatus* Uhler, and it is shown on Plate VI, c.

The Thistle Butterfly an Enemy of Hollyhocks. While inspecting the Elm City Nursery, September 8th, some larvae were noticed devouring the leaves of seedling hollyhocks growing in the nursery. A number of plants had lost nearly all of their leaves. Specimens were collected and taken to the laboratory, and some of these pupated on the 11th. On September 27th two butterflies had emerged. The thistle butterfly, *Vanessa cardui* Linn., is a common species in Connecticut.

Apple Maggot Infesting Huckleberries. During August, 1904, Mr. Walden found huckleberries with maggots in them from which adults were reared that proved to be the apple maggot fly, *Rhagoletis (Trypeta) pomonella* Walsh.

Privet Injured by Lilac Borer. A section of privet stem containing a borer was received from the Elm City Nursery Company during the summer. The stem was eaten partly off, and the larva had eaten along in the pith. From the material was reared a Sesiid moth which is known as the lilac borer, *Podosesia syringae* Harr. The injured stem and the adult insect with pupa case are shown on Plate XII, a. This species also attacks ash, mountain ash and pear.

Arsenate of Lead as a Dip for Plants. In the early summer tobacco plants were attacked by cutworms, and some fields had to be reset or perhaps planted over several times on account of their depredations. Some of the plants were cut off near the ground, but many were injured by having the leaves devoured. Some of the growers applied Paris green to the leaves in order to prevent injury. It occurred to me that at least some of the damage might be prevented by dipping the plants in arsenate of lead after they had been dug and before they were set in the field. Dipping the small plants is a very easy method of poisoning them, and is much more effective than any application of poison immediately after they are set in the field. At first we dipped the tops only, fearing injury if the roots were dipped, but a few were dipped roots and all, and no damage could be detected. On June 19th, 175 tobacco plants were set at Poquonock with the following treatment:

50 plants, tops dipped: $\frac{3}{4}$ oz. lead arsenate in 1 gal. water.
50 plants, tops dipped: $\frac{3}{8}$ oz. lead arsenate in 1 gal. water.
25 plants, tops and roots dipped: $\frac{3}{8}$ oz. lead arsenate in 1 gal. water.
50 plants, untreated.

No injury to these plants could be detected either from the effect of the treatment or by leaf-eating insects.

On June 23d tobacco plants set on the Station grounds were treated as follows:

25 plants, dipped tops: $1\frac{1}{2}$ oz. lead arsenate in 1 gal. water.
20 plants, dipped tops and roots: $1\frac{1}{2}$ oz. lead arsenate in 1 gal. water.
25 plants, dipped tops: $\frac{3}{4}$ oz. lead arsenate in 1 gal. water.
20 plants, untreated.

These plants were afterwards examined, and in no case did the poison cause the slightest injury to the plants. At Poquonock, on account of soil and location, those plants whose roots were dipped made the best growth and were the largest of all when examined on July 26th. Cutworms ceased their depredations about the time of the application, so that nothing was learned regarding the effectiveness of this treatment against them. Flea beetles caused considerable damage by eating the leaves of the untreated plants soon after setting, but the poisoned plants were absolutely free from this injury.

Tests of "American Disinfectant" as an Insecticide. A sample of this material was brought to the Station, and as claims were made for it as having considerable value as an insecticide in the Southern States, we were able to test it on a few plants. In all cases it was mixed with water in fifty per cent. strength, as recommended by the agent. The applications were made June 9th, with the following results:

Apple—dipped—tender leaves and shoots killed. *Aphis sorbi* Kalt. on the leaves were all killed.

Sweet Cherry—dipped—leaves somewhat injured. Not infested.

Rose—dipped—leaves and shoots badly injured. Aphids all killed.

Willow—sprayed—no leaves injured. Only a small proportion of young oyster shell scales were killed.

On account of the injury to foliage, this material cannot be used safely in the proportions recommended.

A Rare Neuropteroid Insect. On February 24th, 1905, I received from Mr. H. J. Goodman of Westville a specimen which he had collected in July, 1904, at Savin Rock, West Haven, which is in the town of Orange. We were able to identify this as *Colobopterus excisus* Hagen., though not in our collection. A photograph was sent to Mr. Nathan Banks, of Washington, D. C., who is a specialist in this group of insects, and he confirmed our determination. We believe this to be the first record of the occurrence of this insect in Connecticut. One specimen is recorded from New Jersey, and it has been taken at Woods Hole, Mass. Mr. Banks writes that it is a rare but widely distributed species.

PLATE I.



a. Small boiler used by Mr. W. N. Dunham, Southington.



b. Portable steam engine boiler, showing method of drawing water from a well by means of an ejector. Outfit of Mr. E. Rogers, Southington.

OUTFITS FOR MAKING THE LIME-SULPHUR MIXTURE.

PLATE II.



a. White or oleander scale on croton leaf.



b. *Euonymus* scale on *Euonymus radicans*. The white shells are males. A few larger grey females are present.



d. Common mealy bug on oleander.

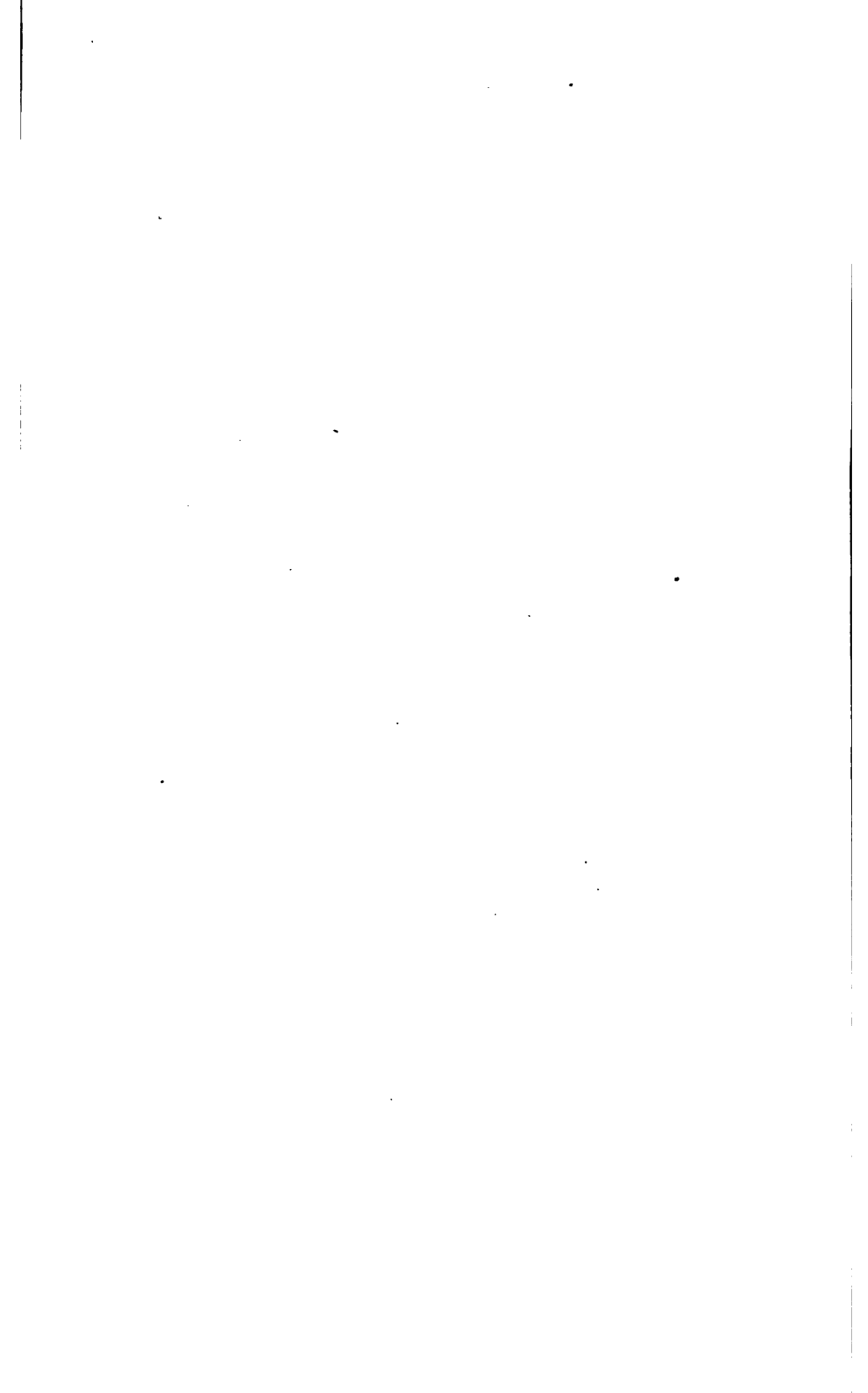


c. Pine leaf scale. Enlarged about twice.



e. The greenhouse orthezia on lantana leaf. Twice natural size.

SCALE INSECTS OF CONNECTICUT.





a. Pit-making oak scale.



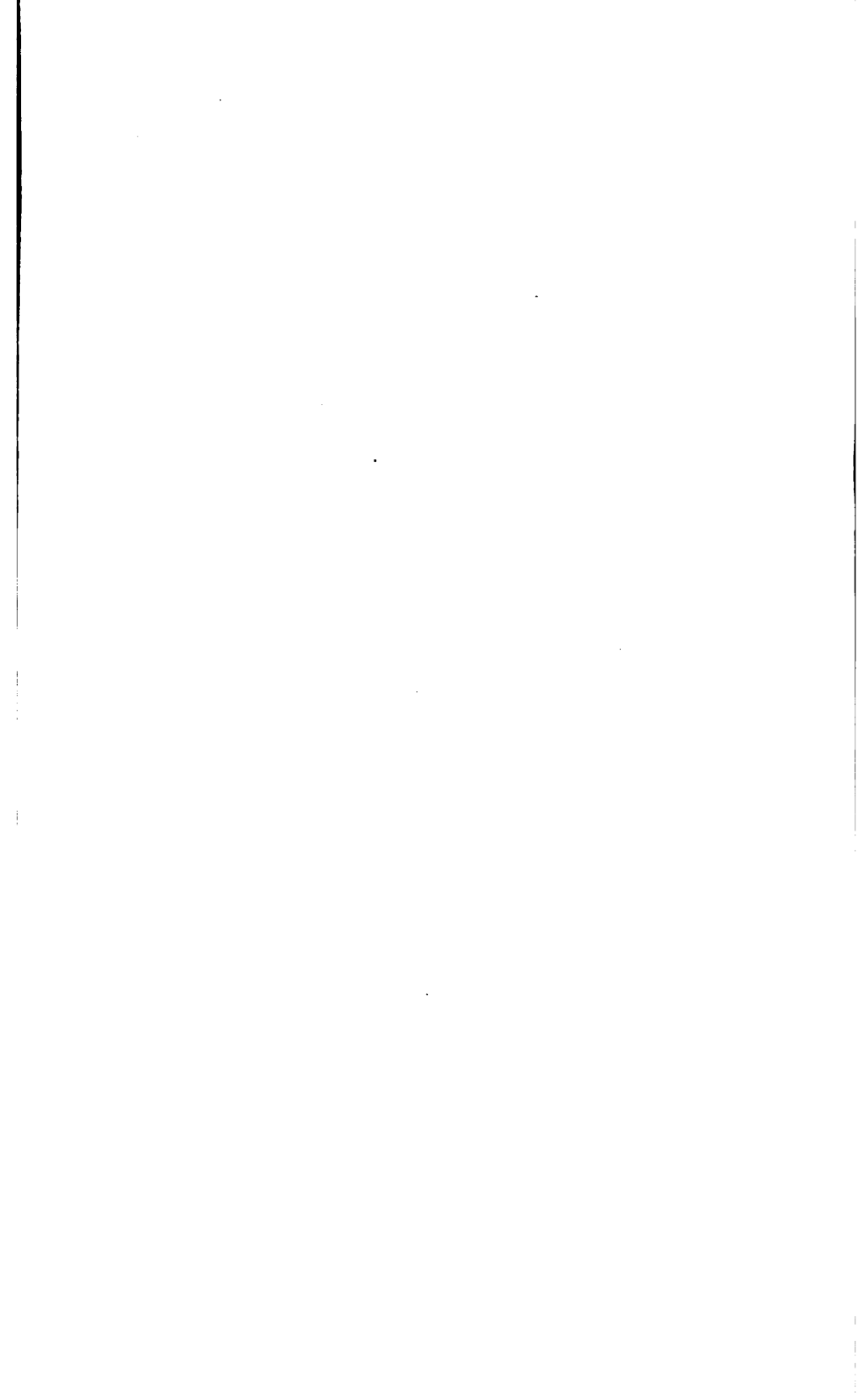
b. Hemispherical scale on fern.

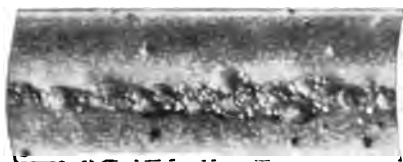


c. Elm scale.

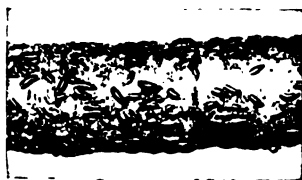


d. Cottony maple scale; females and egg-masses.





a. San José scale on peach twig.
Twice natural size.



b. Oyster shell scale on
poplar.



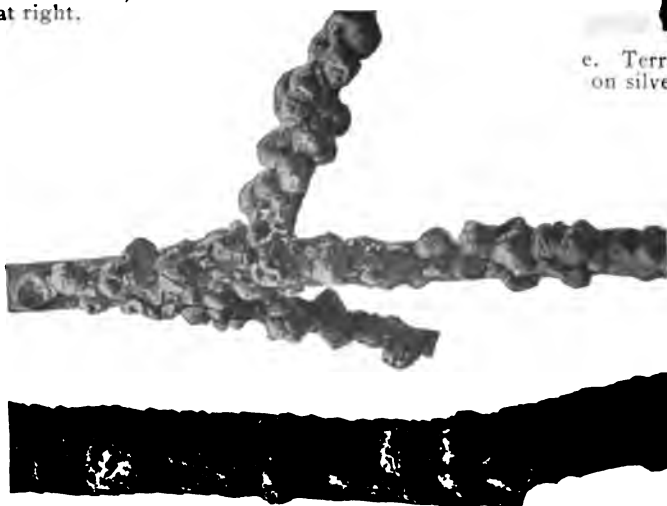
c. Scurfy scale on
currant; males at left,
females at right.



d. Apricot scale on plum;
immature scales at left, old
shells at right.



e. Terrapin scale
on silver maple.



f. Tulip scale on tulip tree. Large females are shown above,
and small male shells on lower twig.



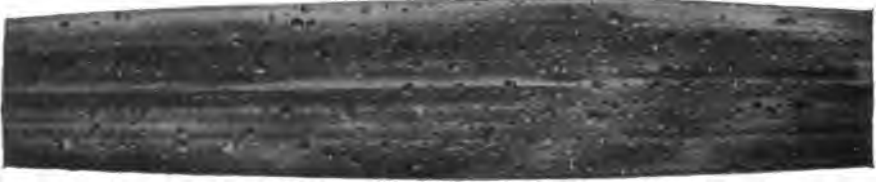
a. Rose scale: twice enlarged.



b. Circular or fig scale on rubber plant.



c. Thread scale on palm leaf.



a. Morgan's scale, different stages on palm.



b. Oak gall scale.



c. *Hormorus undulatus* Uhler.

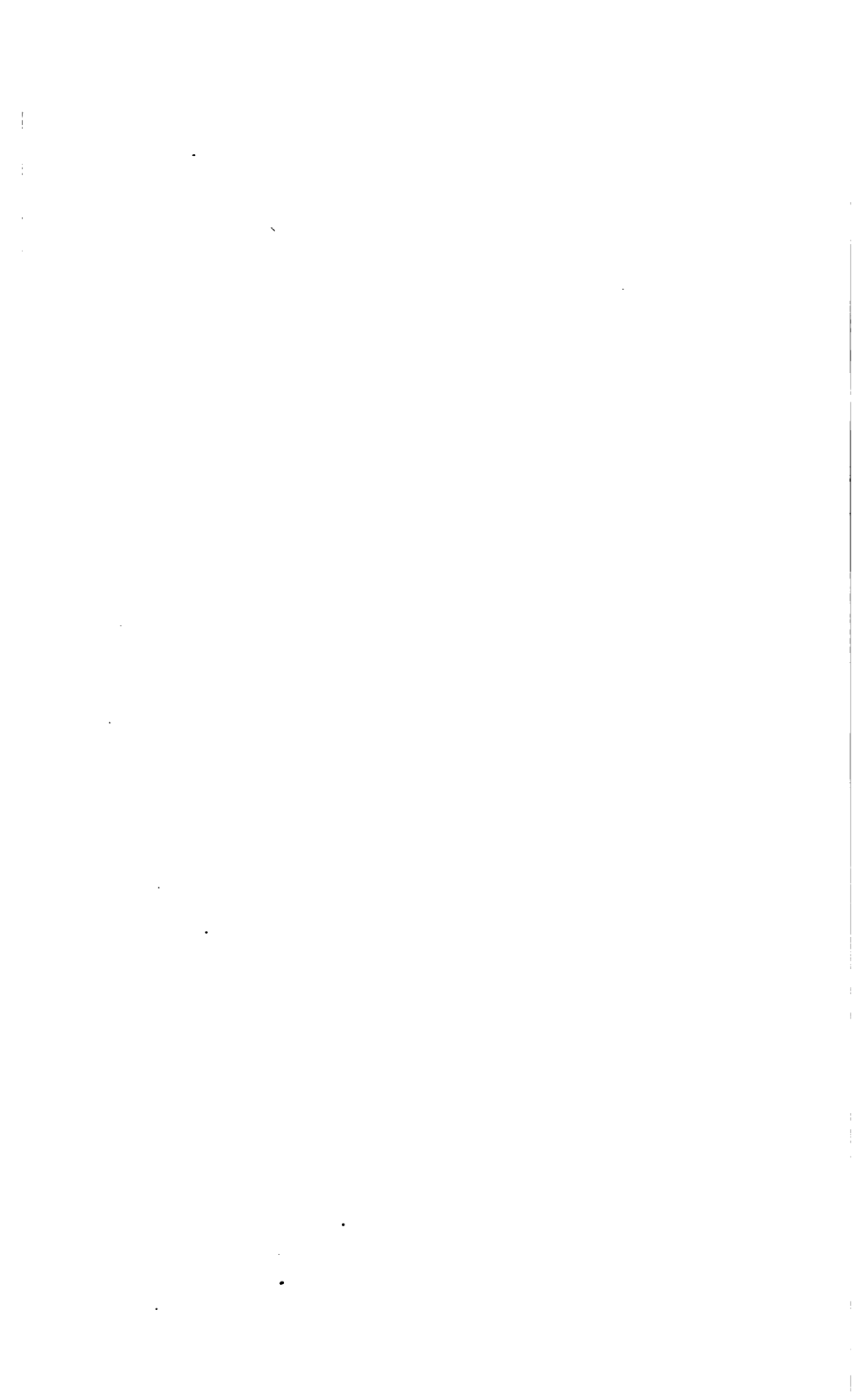


d. Lily of the valley leaf eaten by *Hormorus undulatus* Uhler.

PLATE VII.



Woolly Maple Leaf Scale. Females with egg-masses and young on leaf.
Male cocoons on bark.





White-marked Tussock Moth. Cocoons and egg-masses.



PLATE IX.



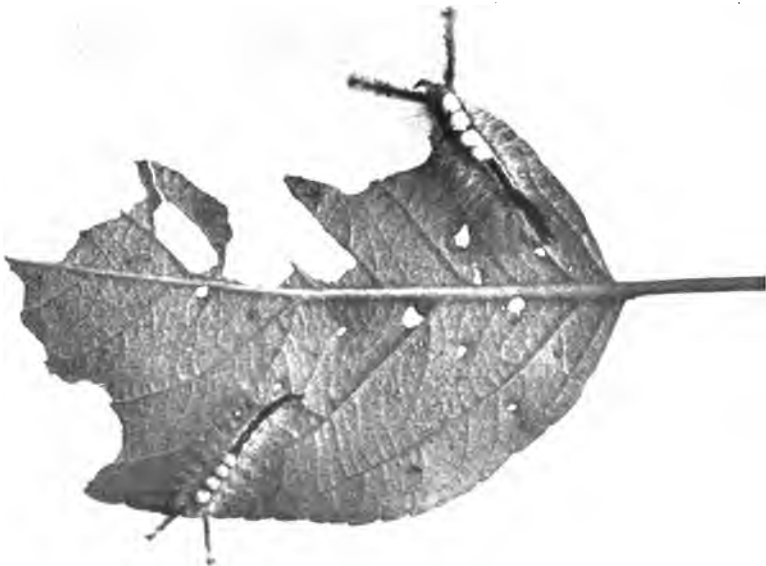
a. Egg-masses.



b. Male moth.



c. Female moth and egg-masses.



d. Caterpillars feeding on apple leaf.

WHITE-MARKED TUSSOCK MOTH.



a. Female and male gypsy moths, natural size.



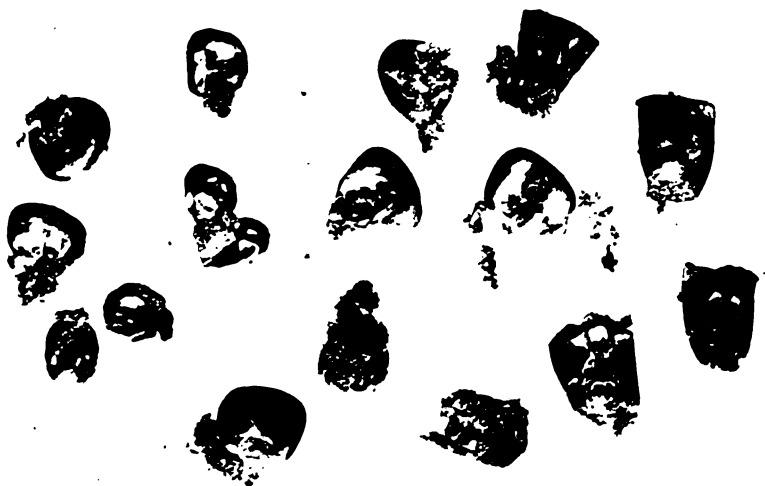
b. Pupæ,
both sexes,
natural size.

c. Caterpillars,
natural size.



d. Egg-masses,
natural size.

THE GYPSY MOTH IN ALL ITS STAGES.



a. Infested kernels of corn.

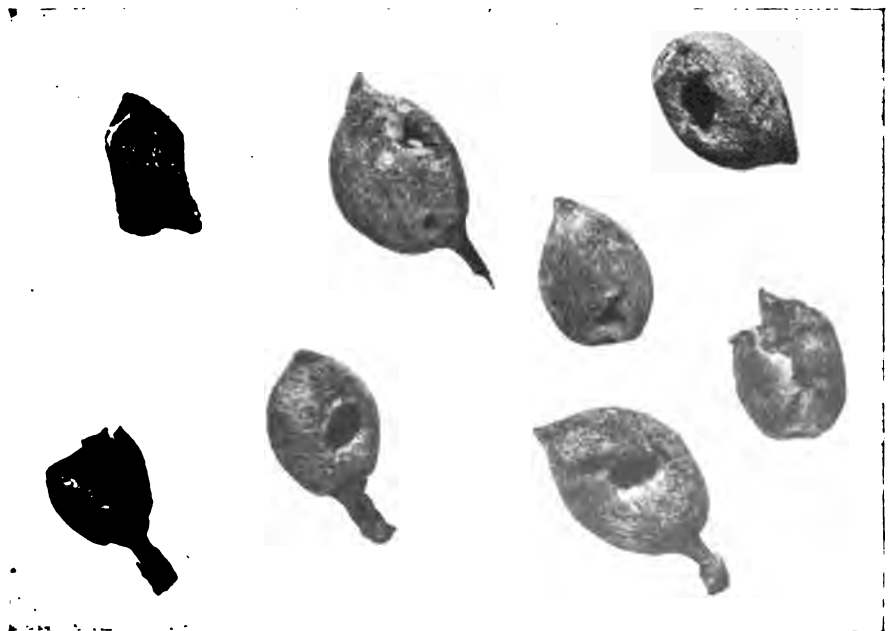


b. Larvæ and web peeled from outside of bag.

THE INDIAN MEAL MOTH.

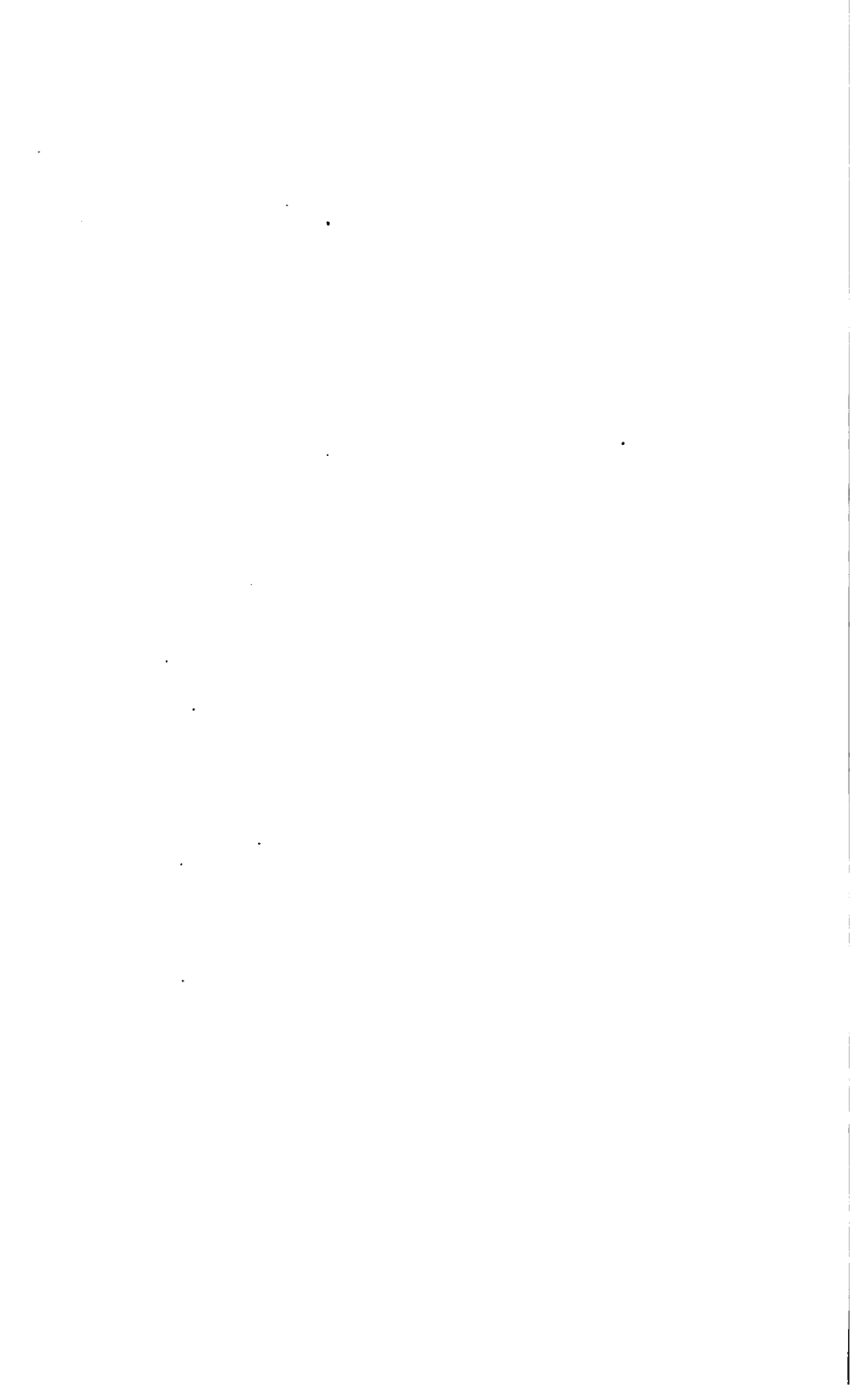


a. Adult and pupa of lilac borer and its injury to privet.



b. Peaches eaten by the rose chafer.

WORK OF ROSE CHAFER AND LILAC BORER.



REPORT OF THE BOTANIST.

NOTES ON FUNGOUS DISEASES, ETC., FOR 1905.

Fungous diseases during the year 1905, on the whole, were less troublesome to cultivated plants in Connecticut than for several years past. This was due to the comparatively dry growing season up to the first part of August. From this time on, however, the weather was sufficiently moist to develop a few troublesome diseases, belonging chiefly to the downy mildew group. The more important of these were as follows:

Brown rot of peach, *Sclerotinia fructigena*, probably took off a third of the crop and was much worse than usual, being one of the most serious fungous outbreaks of the year. The injury was induced by the rainy weather coming on just about harvest time. The loss from rot was felt most seriously in the Wallingford district. Plums, also, were injured but less noticeably.

The downy mildew of grapes, *Plasmopara viticola*, was more abundant than usual this year but no especial complaints were received concerning it.

Muskmelons, though not now so generally planted because of injury from fungous enemies, were largely a failure, partly because of the attacks of the leaf mold, *Alternaria Brassicae* var. *nigrescens*, and of the downy mildew, *Peronoplasmodium Cubensis*. The latter fungus was also injurious to the cucumber, though the injury was not so great as in 1901 and 1902.

The downy mildew of lima beans, *Phytophthora Phaseoli*, was more destructive than it has been since 1897. The oospores of the fungus were found for the first time, though the writer and others had previously looked for them very carefully. The fungus is discussed in detail in a special article later in this report. The rust of string beans, *Uromyces appendiculatus*, also seemed to be more prevalent than usual.

The downy mildew, or blight, of potatoes did not appear until after the middle of August. By that time the combined injuries of potato bugs, flea beetles, dry weather, and early

blight (this last being more prominent than usual) had killed the potatoes in many fields, so that these, missing the blight on the foliage, did not suffer subsequently from rot of the tubers. Those fields, however, that were still green when the blight did appear were gradually killed by it and the tubers often rotted considerably. Thus, while there was considerable complaint of rotten potatoes, this injury was not as great as in 1904, and the blight injury to the foliage was still less conspicuous.

Point-rot of tomato did some damage to the fruit—more than has been noticed for several seasons. It was not determined whether this trouble was due to bacteria or fungi, but superficial observations seemed to indicate both as primary agents of the disease.

NEW DISEASES.

The following troubles were not necessarily especially injurious in 1905 but are briefly described here because they have not been mentioned before (see Reports of Botanist for years 1903 and 1904) as occurring in Connecticut.

APPLE, *Pirus Malus*.

FRUIT SPECK, *Fungus undet.* Plate XIII, a. In February, 1905, Mr. E. M. Ives of Meriden gave to the writer for examination specimens of apples showing superficial small spots or specks scattered over the skin. This trouble, while observed by Mr. Ives at harvest time, did not develop conspicuously until some time after storage. The same trouble has been observed by the writer the present winter on apples in the New Haven markets and also on specimens of the Tallman variety at the mid-winter exhibition of the Connecticut Pomological Society. These areas of brownish dead tissue usually varied from the size of a pin head to a quarter of an inch in diameter and extended but slightly into the flesh. The diseased spots in some cases were even more thickly placed than on the Tallman Sweet in the illustration given here. Frequently one could see at the center of the specks small ruptures, as if made by insect-puncture, or possibly the trouble started at the lenticels and these were of that nature. Cultures in test tubes were made at different times by taking diseased tissue beneath

the epidermis with a sterilized knife and these all developed a fungous growth but in some cases mixed with bacteria. As the fungus was apparently the same in all the cultures, presumably it was the primary cause of the trouble, but it cannot be a very aggressive parasite since the spots remained so small and developed so slowly even on the stored fruit. Nevertheless it is a serious pest for certain varieties in that it greatly mars their appearance and possibly later opens the way for more extended and deep-seated rotting. According to Mr. Ives, Tallman Sweet was the variety most seriously affected, Northern Spy suffered less, while Baldwin was injured but little. From this it would appear that the more tender or earlier maturing winter varieties were more susceptible of attack. Mr. Ives also informs the writer that these apple trees were sprayed in 1905 and the disease did not trouble the crop of that year. No reference in literature has been seen that relates to this trouble, which apparently is a common one.

BEAN, LIMA, *Phaseolus lunatus*.

POD AND LEAF BLIGHT, *Phoma subcircinata* E & E. Plate XIII, b. Halsted in 1892 briefly mentioned in the 12th Ann. Rep. of N. J. Agr. Exp. Stat., p. 287, under the name of *Phyllosticta* sp., a fungus collected on the pods and leaves of Lima beans. In 1893 Ellis also described, in the Proc. Phil. Acad. Nat. Sci., a new fungus on the pods of Lima beans, calling it *Phoma subcircinata* E. & E. In a more detailed description in Bull. 151 of the N. J. Agr. Exp. Stat., p. 24-5, Halsted identifies Ellis' fungus as the one to which he had previously referred. The past year the writer found a fungus, apparently the same as described and illustrated by Halsted, on the leaves of Lima beans in the vicinity of New Haven. It was not observed on the pods but may have escaped notice because it was not especially looked for there. While attacking leaves here and there on the plants, the injury was not especially conspicuous in the field. The fungus produced large subcircular, or more irregular, brown, often bordered, spots that gave evidence of their development through faint, elevated, concentric rings of growth. The spore receptacles showed as numerous small black specks immersed in the tissues. In time the dead tissues cracked more or less and wore away, leaving

holes in the leaves. Our specimens do not agree exactly with those issued by Ellis (N. A. F. No. 2840) on the pods, since their spores average larger, $5-12\mu$ by $2.5-3.5\mu$, and are occasionally septate. This might be considered by some sufficient to place the fungus under the genus *Ascochyta*, and Saccardo has described a species, *A. Phaseolorum*, with spores 10 by 3μ , that possibly may be the same as this.

BUTTERNUT, *Juglans cinerea*.

WHITE MOLD, *Microstroma Juglandis* (Berang.) Sacc. This is not an uncommon parasite of butternut leaves, forming white moldy growths more or less thickly on their under sides. Presumably it is not a serious pest. Dr. Britton collected specimens on wild butternuts the past summer at New Canaan.

CATALPA, JAPANESE, *Catalpa Kempferi*.

LEAF SPOT, *Macrosporium Catalpae* E. & M. Plate XIV, 2 This trouble was conspicuous during the past summer on a Japanese catalpa at the Experiment Station. Reddish brown, bordered spots, 5 to 10 mm. in diameter, are formed more or less abundantly on the leaves. The tissues of these spots are dead and often crack apart, sometimes falling out. When the trouble is serious the trees are partially defoliated. It has been observed on different species of catalpa in various parts of the United States and has been discussed most extendedly in the Ann. Rep. U. S. Dept. Agr. for 1887, pp. 364-5. Experiments are reported there in which spores of this fungus, and also of another found with it, failed to produce these spots when sown on catalpa leaves. From what the writer saw of the disease he has been led to believe that possibly the *Macrosporium* (*Alternaria*) develops on the leaves as a consequence and not as the cause of these dead spots. The fungus belongs to a genus whose species are more often saprophytic than parasitic and are apt to occur on dead tissues. The spores were found only sparingly on the dead spots and sometimes did not seem to be present. No other fungus, however, was observed on these, and so if they were not caused by the *Macrosporium* they probably were not the result of injury by any other fungus. Further study of the trouble is needed to definitely determine its cause.

CELERIAC, *Apium graveolens* var. *rapaceum*.

LEAF SPOT, *Septoria Petrosellini* var. *Apii* Br. & Cav. Plate XIV, b. Celeriac is merely a variety of celery having a swollen base. It is not largely grown in Connecticut, but specimens raised for the New Haven market were found to be injured by the leaf trouble which so frequently occurs here on celery (see Report of this Station for 1903, p. 314).

DANDELION, *Taraxacum officinale*.

RUST, *Puccinia Taraxaci* Plow. This rust, so common on dandelions as weeds, was also observed on dandelions cultivated by a Highwood market gardener; but it was not causing serious injury. The spores form dusty reddish brown outbreaks, about the size of a small pin-head, scattered more or less thickly over either surface of the leaves.

MAPLE, SUGAR, *Acer saccharum*.

Leaf Scorch. Plate XV, a. During the past summer and fall maple leaves similar in appearance to that shown in the illustration were sent to the Experiment Station from different parts of the state with inquiry as to the cause of the trouble. Similar specimens and requests have been received in years past. The leaves die at the margins, forming irregular brown patches extending inward a greater or less distance. Sometimes isolated spots are formed wholly surrounded by healthy tissue. In time there often appears a more or less conspicuous blackish growth of saprophytic fungi on the dead tissues. The appearance of affected leaves moreover is very similar to that produced by a true fungous parasite of the maple, namely *Glaeosporium saccharinum*. In no case, however, was this fungus found on the leaves sent in for examination. The trouble is undoubtedly a physiological one, such as has been described by Stone of Massachusetts and Stewart of New York as occurring in those states. For some reason (due probably to drought or winter injury to the roots) the leaves under certain weather conditions are not able to replace the water in their tissues from the roots as rapidly as it is lost through transpiration, and the death of the tissues from the margin inward results. According to Stone the trouble may be produced by unusually favorable

conditions for the transpiration of water, such as high winds on clear warm days, when the available water supply of the roots is small. Most observers report the trouble as appearing suddenly. A somewhat similar injury to elm leaves, apparently due to the same causes, has also been reported frequently in the state.

NECTARINE, *Prunus Persica* var. *necturina*.

BROWN ROT, *Sclerotinia fructigena* (Pers.) Schröt. The nectarine is only occasionally grown in the state, but these few trees seem to suffer considerably from fungous attacks as well as from winter injury. Specimens of the mummied fruit collected in January showed abundance of the *Monilia* stage of the brown rot fungous. While this is very common on other species of *Prunus* in the state, it has not been reported before for this host though apparently not uncommon on it.

SCAB, *Cladosporium carpophilum* Thm. Plate XV, b. In September specimens of nectarines were received from Thompson, Conn., that were badly injured by the scab fungus which is so common in Connecticut on the peach. As the nectarine is a smooth fruit, the injury more nearly resembles that produced by scab on plums than that on the peach. The skin becomes more or less thickly covered with the circular, brownish scab colonies which occasionally merge together. The fungus incites the formation of a corky growth of tissues and causes more or less cracking in these. The badly infected fruit is said to drop prematurely or else mature imperfectly. As in the plum, the injury to the tissues is more conspicuous than the fungus, while on the peach it is the olive fungous growth that forms the conspicuous spots, the hairy covering no doubt protecting the fruit somewhat and at the same time permitting a more vigorous external growth of the parasite. An examination of the twigs seemed to indicate that the fungus carried over the winter on these as it does on the peach. The preventive measures are the same as those for peach scab (see Report 1903, p. 340).

OKRA, *Hibiscus esculentus*.

WILT, *Neocosmospora vasinfecta* (Atk.) Sm. Plate XVI, a-b. This fungus is very injurious to cotton in the south and was first described by Atkinson (Bull. Ala. Agr. Exp. Stat., 41:

19-24) in 1892. He mentions in this bulletin, p. 25, that okra, which is botanically related to cotton, is sometimes attacked. Smith (Bull. U. S. Dep. Agr., Div. Path., 17: 31) and Orton (*Ibid*, Bull. 27: 6) both mention okra as having a wilt disease which they consider the same as that of cotton though their identity has not been absolutely proved. Okra is a salad plant occasionally grown in private gardens in this state. Some plants in the Experiment Station grounds the past year showed unmistakable signs of the disease in August and September. The year before some cotton had been grown in the garden a short distance from where the okra was situated. If the disease occurred on this, however, it escaped notice. There are a number of these wilt troubles of cultivated plants that have been described as distinct, such as wilts of cotton, cucurbits, potato, tomato, flax, etc. Several of these occur in this state and the tomato trouble has been especially bad in the Experiment Station greenhouse for years. As they are all caused by *Fusarium* soil fungi (of which the mature stage has been observed only in one or two cases) and these act much the same on all of the hosts, there may be some question whether they are really caused by different species or merely strains of the same semi-parasitic soil fungus.

The diseased okra plants when first seen by the writer in September looked as if they had been partially killed by the frost; see Plate XVI, a. The trouble showed first on the lower leaves, gradually affecting those above in succession. They became yellowish in irregular streaks from the margin inward and eventually brown and dead. In time the whole leaf is killed and it is usually dehiscent at the customary place on the node; see Plate XVI, a. Thus a badly diseased plant may gradually drop all of its mature leaves and finally begin to die at the tip of the stem. The character of the disease is shown on cutting transverse or longitudinal sections of the stem. The woody layer which occupies a prominent band between the central pith and the outside bark appears in these cases plainly diseased, having a dark brown color; see Plate XVI, b. This discoloration of the wood even shows when the outside of the stem appears normally green and healthy. Microscopic sections demonstrate that the diseased condition is caused by the presence of the *Fusarium* stage of the fungus which develops

vigorously in the vascular bundles, more or less completely filling the water-carrying ducts and causing disease of their walls and the surrounding tissues. The fungus even penetrates eventually into the bundles of the leaf petioles. Thus the water supply of the leaf is gradually cut off and the blade finally dies.

These wilt fungi apparently develop to a certain extent on decaying rubbish in the ground and thus become more troublesome from year to year if the land is used consecutively or continuously for plants liable to infection. In some cases, as unquestionably with the tomato wilt, the seeds from diseased plants may carry the trouble and serve as a means of infection. The continued use of the same soil in hot beds favors the establishment of the fungus there, when it becomes a means of infecting the young plants of tomatoes and egg plants. Egg plants, especially when transplanted to apparently uninfected fields, often suffer seriously, even though they showed no sign of the disease in the young plants transferred from the hot-bed. All these points must be taken into consideration in combatting wilt troubles. Spraying, because of the infection of the plants through the underground parts, is of little use. Apparently soil treatment with chemicals will usually be of little practical value though based on good theoretical grounds. Orton was successful, with cotton, in rearing plants that were wilt proof through selection of wilt resistant individuals in the infected fields.

ONION, *Allium Cepa*.

BRITTLE, *Fusarium*? Plate XVII, a. Early in June, 1905, the writer, with Dr. Britton, examined an onion field owned by Mr. Burton W. Bishop of Guilford to determine the cause of a disease which is a serious menace to the onion industry in that region. According to Mr. Bishop, at least one hundred acres of desirable onion land in the vicinity of Guilford are not available for growing onions because of this trouble. It usually starts in some section of a field and spreads in area from year to year, as the onions are generally grown continuously on the same land. In Mr. Bishop's field the disease had appeared the year before near a stone fence and this year was occupying a considerably larger area. In a neighbor's field the trouble apparently started from a spot on which a manure pile had

recently stood. A report from Mr. Bishop after the onion season was over showed that the disease did not progress much later in the season, thus indicating that it is chiefly injurious to the young plants. At the time of the visit the onions in the main part of the field examined were several inches high and well beyond the dampening off stage. In the infected areas they averaged much smaller and the stand was very poor. Mr. Bishop stated that the weeds in these infected areas usually made a poor growth, but this was not evident, at this time, to the writer.

One of the most general characteristics of the disease is the brittleness of the onion leaves, from which character the disease takes its name. Another very evident character is the peculiar curling of the leaves of some of the plants. In exaggerated cases these leaves had developed spiral coils of two to three turns, as is shown in the illustration. Frequently the leaves are unevenly thickened or constricted and show somewhat indefinite yellowish spots. The general appearance of the plants suggested that possibly the disease resulted from insect injury of some kind, but neither Dr. Britton nor the writer could find any evidence to support this theory. Neither was there any evidence of a fungus attack on the parts above ground. Usually the roots appeared normal when the plants were pulled up and later examination in the laboratory showed no sign of any external fungus at work on them. However, when the plants were taken very carefully from the ground without breaking off the smaller roots, examples were found in which some of the roots, especially toward the extremities, showed slight irregular swellings, and these roots were more brittle than normally but otherwise appeared perfectly healthy.

Microscopical sections of these roots, even in places not enlarged, showed the presence of an internal mycelium of some fungus. The mycelial threads were most evident in the intercellular spaces around the parenchymatous cells and not infrequently sent conspicuous irregular branches into these, causing plasmolysis of their protoplasmic contents, but, so far as observed at this stage, no evident injury to the cell walls. Apparently the presence of the fungus caused an unusual local multiplication of the parenchyma cells, resulting in the irregular swellings of the roots. No sign of the mycelium was found in

the tissues above ground even when their malformation was conspicuous. Probably this injury resulted in some way from the stimulating or irritating action of the mycelium in the roots. Whether later in the season the fungus penetrated into the leaf tissues or caused further disease of the roots was not determined. Specimens of the infected onions left exposed for a few days in a moist chamber developed growths of several, apparently saprophytic, fungi, but no special growth showed on the enlarged roots. The most conspicuous of these external fungous growths was that of a species of *Fusarium*.

Soil from an infected field was brought to the Experiment Station greenhouse and placed in two boxes and a third box was filled with the soil used in the greenhouse. Onion seed was planted in each of these, but in one of the boxes of Guilford soil a heavy coating of a mixture of lime and sulphur was scattered over the seed in the rows before covering. The young plants in the untreated Guilford soil dampened off considerably more than in either of the other two boxes, but none of the plants in any of the boxes developed the peculiar malformation or brittleness observed on the diseased onions in the fields. The plants were kept under observation several months. Those grown in the treated soil made the least growth, as undoubtedly too much lime and sulphur was used for their best development; those in the untreated Guilford soil had a poorer stand but made a slightly better growth; while those in the greenhouse soil made by far the best growth. This might indicate that the Guilford soil was somewhat deficient in plant food, but Mr. Bishop states that it had been liberally fertilized.

Everything considered, the trouble seems to be caused by some soil fungus, possibly a *Fusarium*, as the mycelium observed in the roots could easily belong to such a fungus and it is known that this genus furnishes several soil fungi. Its development in the onion fields seems to be due to the practice of growing onions continuously on the same land and using manure as a fertilizer. Probably the disease would cease to be troublesome if a proper rotation of crops on the land was followed, such as corn, onions, rye and clover, using stable manure only the year the land was in corn and commercial fertilizers at other times, especially when in onions. Possibly when infected land is used the trouble could be lessened by isolating

the infected part by a ditch from the remainder of the field and by the use of chemicals, such as sulphur and lime, in the drills in the infected area.

PLUM, *Prunus* sp.

BACTERIAL BLACK SPOT, *Pseudomonas Pruni* Sm. Plate XVII, b. In the summer of 1904 Mr. F. L. Perry of Bridgeport brought to the Station green plums showing a disease, apparently of bacterial origin, but which was not definitely determined at that time. The past summer similarly diseased plums were received from Rhode Island, and at our request Mr. Perry sent specimens from Bridgeport. This trouble, apparently, occurs only on the Jananese plums, but may attack any of the varieties of these, according to growers. The green plums show conspicuous black-purple spots which are often slightly sunken. These spots vary in size up to half an inch in diameter. There are not many on a single plum and these are usually isolated. The diseased tissue does not extend much below the skin, so the injury is quite superficial. Usually only a few plums scattered over the tree show the trouble, but occurring on the green fruit one is apt to fear that later it will develop into a very serious pest. This does not happen, as the trouble becomes less conspicuous and vigorous on the ripening fruit and fails to spread further. Specimens of the nearly grown but green fruit when placed in a moist chamber in the laboratory did not show any further progress of the disease though kept for some time under observation. Cultures made from diseased tissue from the interior uniformly gave growths of a yellow motile organism, thus showing bacteria to be the cause.

So far as found by the writer, this disease has been described only by Erwin F. Smith in short notes (Science, 17: 456-7, 1903, *Ibid.*, 21: 502, 1905) from his extended studies of the disease, which he found on Japanese plums in Michigan. Dr. Smith states that the disease also occurs on the leaves forming numerous small water-soaked spots which finally may end in shot holes. The writer has not had the opportunity to examine infected trees to see whether the disease affected the leaves here, but the correspondents have not complained of injury to these. In the Report of this Station for 1903, page 337, the writer called attention to a bacterial spot of peach

leaves about which nothing at that time had been written. The general appearance of these leaves seems to be similar to that described by Smith for the diseased plum leaves. No cultures were attempted from the peach leaves, so it is impossible to state definitely whether their disease was caused by the same organism as the plum disease. Smith discovered in his investigations with the plum spot that the bacteria gained entrance into the leaves and fruit through the stomates and for some time confined their development to the substomatic cavities. He also found that the disease was chiefly of meristematic tissue, which accounts for its failure to progress with the maturity of the leaves and fruit. While the disease in its present condition is not very serious, one can not assume that it will remain so since it may spread to other varieties and become more virulent. Though of bacterial origin, it is quite different from the bacterial blight that has been found occasionally on the plum and commonly on the pear, etc., in this state.

RASPBERRY, *Rubus* sp.

GREY MOLD, *Botrytis patula* Sacc. & Berl. This fungus was collected at the Frisbie farm, Southington, in July, 1902, on the fruiting canes. These were dying prematurely, apparently from the attack of some fungus. While this fungus was by far the most conspicuous one found in the stems, it may not have been the primary cause of the injury, as the cane wilt fungus, *Leptosphaeria Coniothyrium*, was also present. The *Botrytis* formed a greyish growth which broke out in small sori on the epidermis, but these were often so closely placed that they formed a conspicuous felt-like mat, resembling considerably that of a vigorous downy mildew. The spores are large and look more like those of the *Peronosporae* than they do those of *Botrytis*. The fungus is certainly not a typical *Botrytis* and possibly does not belong to that genus, but further study with fresh material would be necessary to determine its exact relationship, as it is difficult to say from the old material how the spores are borne. This species was described in 1885 by Saccardo and Berlese from specimens sent by Ellis from New Jersey. In the Syll. Fung. 4, p. 25, the host is given as *Salix* (?) which is apparently a mistake,* as specimens collected by Ellis

* In the host index, volume 13 of the Syll. Fung., both *Salix* sp. and *Rubus strigosus* are given as hosts.

at Vineland, N. J., June 28, 1884, and which the writer has examined, through the kindness of Dr. Underwood, from the N. Y. Bot. Gard., are labeled "on living red raspberry canes." Apparently the fungus has been very rarely collected.

SPINACH, *Spinacia oleracea*.

LEAF MOLD, *Heterosporium variabile* Cke. Plate XVIII, a. Halsted, of New Jersey, who has issued a bulletin on the fungi which attack spinach, does not give this fungus in his list, though he does mention other molds that appear on the old leaves. It was described originally by Cooke, of England, in Grevillea, 5, p. 123, in 1877, and the host was given as "languishing leaves of Spinacia." The specimens collected by the writer were on leaves of spinach obtained in the New Haven market in January. Usually only the outer two or three leaves of each head were attacked by the fungus. These leaves showed subcircular dead spots, about a quarter of an inch or less in diameter, which were more or less densely covered above and also usually below with a conspicuous olive-black moldy growth. When the spots were thickly placed the intervening tissue was a sickly yellowish color and the leaf worthless. Even when the spots were not so abundant the market value of the spinach was lessened because of its appearance. The fungus may or may not be a true parasite, as the writer has often seen spinach leaves in the fields with spots on them but with no sign of fungous growth. That it is not a very vigorous parasite was shown by its presence being limited largely to the older leaves. A species of *Alternaria* which produces a general appearance very similar to this fungus has also been observed on the older leaves of spinach in the market.

SQUASH, *Cucurbita Pepo*.

DOWNY MILDEW, *Peronoplasmopara Cubensis* (B. & C.) Clint. The squash is a host not before reported for this fungus in Connecticut. The appearance of the infected leaves was so different from that of the usual hosts that the writer did not recognize the trouble at the time of collecting it but mistook it for a bacterial leaf spot. The leaves were thickly covered with

small angular brown spots which were more conspicuous on the upper than on the lower side and much smaller than those ordinarily seen on the musk melons and cucumbers. There was no evident growth of the fungus and the microscopic examination revealed the presence of only a few conidiophores. The spores, apparently, averaged smaller than on some of the other hosts.

STRAWBERRY, *Fragaria* sp.

Leaf Scorch. About the last of June, 1905, Dr. Britton and the writer visited Mansfield Bros.' farm at West Hartford to determine the cause of an unusual trouble of their strawberry plants. Many of these were drying up and dying. The older plants suffered more than the younger and the older leaves before the newer leaves on the same plant. The leaves turned purplish and then gradually dried up and died. No sign of insect or fungous work was visible on them and an examination of the roots and crowns gave no indication of any special pest as the cause of the injury. The plants suffered most where the matted row method of culture was used. As the early summer had been unusually dry, the writer finally came to the conclusion that this was largely responsible for the trouble, though this injury did not show prominently until the very dry weather was past. Possibly the trouble was aggravated by winter injury of the roots and the method of culture, which was not so well adapted to dry weather.

POWDERY MILDEW, *Sphaerotheca Humuli* (D. C.) Burr. Plate XVIII, b. This mildew had not been collected in the state until last June, when Dr. Britton found, at Poquonock, a few infected plants in a field near a manure pile. It is a trouble, however, that is rarely reported injurious to the strawberries. The leaves become covered on either surface, but showing most conspicuously on the upper, with a mealy white growth of the fungus. This is the conidial or summer stage and the winter spore stage is rarely formed on this host.

TOBACCO, *Nicotiana Tabacum*.

DAMPENING OFF, ? *Sclerotinia* sp. Plate XIX, a-b. Several seed-bed troubles of tobacco have been described by Selby in a recent bulletin, No. 156, of the Ohio Experiment Station, but

apparently the one mentioned here is different from any described by him. In appearance, Plate XIX, b, the injured plants were very similar to those figured by Selby for a bed-rot injury caused by a *Rhizoctonia* fungus, but examination of the specimens received here did not reveal the presence of this fungus. The disease showed on the young plants at the base of the stem as a conspicuous dead area or a complete girdle. Often the injury was so severe as to cause the death of the plant. When placed in a moist chamber the infected plants produced a growth of a sterile white fungus at the injured part. Plate XIX, a, shows cultures of this fungus growing on potato agar. These cultures never produced any spores but instead formed the numerous small sclerotia similar to some of those described by Smith for the *Sclerotinia* drop fungus of lettuce, which is also a soil fungus.

Mr. W. E. Frost of Bridgewater, who sent the diseased tobacco plants, wrote in part as follows: "Is there anything that can be done to stop the rotting of tobacco plants in the seed beds? Where they rotted last year they are doing so this year. Can anything be done so that it will not appear in the same beds another year? Would it be safe to set plants from beds where there is some rot if the plants appear all right when taken up?" Fungous troubles in seed beds are chiefly due to two conditions: first, keeping the plants too moist by improper watering, insufficient ventilation or crowding the plants too closely together; second, fertilizing with manure or using the same soil in the beds year after year, thereby establishing in these special injurious soil fungi. When the trouble is of the second sort, as in the present case, the soil should be changed or new beds made and where feasible only artificial fertilizers should be used. Applications of lime and sulphur to infected soil possibly in some cases may prove of benefit. In answer to the last question asked by Mr. Frost, it may be stated that the writer set out some of the least diseased plants received and these did not develop the trouble any further and did fairly well during the whole season. There are some diseases, however, contracted in the seed beds, as the wilt of egg plants, where the infected individuals do poorly the whole season.

DOWNY MILDEW, *Phytophthora Phaseoli* Thaxt., OF LIMA BEANS.

In the Botanical Gazette (18) and the Annual Report of this Station (19) for 1889, Professor Thaxter, then botanist of the Station, recorded the discovery of the Lima bean mildew, which he found doing damage in Connecticut. Besides giving a general and scientific description of the fungus, Thaxter described and illustrated in detail the parasitic, or summer stage, but he was not successful in discovering the oospores, or winter stage. His successor, Dr. Sturgis, also in the Botanical Gazette (16) and the Reports of the Station (15, 17) added to our knowledge of the fungus by describing its methods of infection, especially that accomplished by the aid of insects, and recorded successful spraying experiments. He, too, failed to find the oospores, though special search was made for them. The writer adds, in this paper, his contribution to the knowledge of the fungus in a description of the missing oospores and of artificial cultural experiments. Practically all that is known of the mildew, except its limited distribution, has resulted from the work of the botanists of this Station. It is fitting, therefore, that a detailed account of the fungus, its injury and methods of prevention, be given in this place.

PARASITIC, OR SUMMER STAGE.

Relationships. The Lima bean mildew belongs to the small genus, *Phytophthora*, which is especially characterized among the downy mildews by the nodular swellings on the conidiophores (spore-bearing threads) that mark the position of the successively developed spores. The genus includes serious parasitic pests, the most conspicuous of which is the downy mildew, or blight, of potato. This is the only other species that occurs in Connecticut. Another species, found in the East Indies, has tobacco for its host, and a fourth is injurious to seedlings of beech, Coniferae, etc. One or two other species have been described recently. Apparently the mildew of Lima beans is most closely related botanically to the species that occurs on tobacco.

Distribution. Thaxter first found the Lima bean mildew in September of 1889 at Hamden, Conn., near New Haven, where

it had been injurious at least two years before his discovery. In the Report for 1890 (20) he writes: "This mildew (*Phytophthora Phaseoli*) described and figured in last year's report, has been again destructive this year and has made its appearance in a number of new localities in the neighborhood of New Haven. So far as ascertained it extends from New Haven to Hartford and west to South Norwalk, but has not yet been discovered outside of Connecticut." So far as recorded, Sturgis' work and observations on the fungus were in the vicinity of New Haven (East Haven, Westville, etc.). The writer's experience, too, has been limited to this vicinity, though complaint of it has been received from Green's Farms. Probably the fungus has appeared in Connecticut (in a more or less conspicuous way) each year since its discovery. Thaxter collected specimens in 1889 and 1890. Sturgis records it as being injurious "for some years" in 1893 but failed to find it that year in localities where it had always been abundant; he also records it for the years 1897 and 1898 and states it was prevalent for two or three years previous. Rorer collected specimens in 1901 and the writer made collections in 1902, 1903 and 1905.

Outside of Connecticut the fungus was first reported in New Jersey by Halsted (4) in 1897, and he has found it several times since in the same state. It was also reported about this time by Speschnew (13) from Tiflis, Russia, and has been found by other Russian botanists. Smith (12) states it was injurious in 1903 in Delaware. So far as the writer has learned, these are the only published records of distribution. Thinking that possibly it had been noticed but not reported in other of our eastern states, where the chances for its introduction and development seemed favorable, information on this point was asked of the Division of Vegetable Pathology and Physiology of the U. S. Department of Agriculture and of the Experiment Station botanists of fourteen states, chiefly those bordering on the Atlantic coast. Letters received from these showed that the mildew had not been observed in any other states than those mentioned except in two cases. Mr. Stewart, of the Geneva Station, N. Y., reports the receipt of specimens from Long Island once each in 1904 and 1905, and Mr. Woods, of the Division of Vegetable Pathology and Physiology at Washington, states that the fungus was very injurious in Frederick county, Maryland, in 1905.

Injury to host. So far as reported, only the Lima bean, *Phaseolus lunatus*, is subject to the attacks of this mildew. The writer has seen it on both the pole and dwarf varieties, though rarely on the latter. The dwarf varieties are not usually grown on a commercial scale in Connecticut and probably do not present so favorable conditions, as regards moisture, for the spread of the fungus, though Sturgis has reported a case where they were severely injured. The pods are the parts of the host most subject to attack, but the fungus also occurs to a limited extent on the young leaves, vines and flowers.

The growth of the fungus on the pods, Plate XXII, a-b, is often very conspicuous, forming a dense pure white felt of the conidiophores in irregular patches, or sometimes spreading over the entire surface, on one or both sides. Both Thaxter and Sturgis have noted that the mildew often at first is present only on one side of a pod, and the latter states that this is usually the side furthest from the vine and least protected by the leaves. The injury to the pod generally shows but little beyond the area covered by the fungus, though the green of the healthy tissue may be separated from the diseased by a more or less distinct purplish border. As a pod becomes more and more severely injured it wilts and gradually dies, shriveling up in the irregular form shown in the illustration. The fungus eventually penetrates into the interior of the pod, causing the tissues to become sunken, and the mycelium may enter the seeds. Many pods are attacked so vigorously in their infancy that they are killed outright and others are injured so they never mature. The injury to the large pods varies with the abundance of the fungus, but even when not preventing maturity of the seeds it may still affect their market value by injuring their appearance. The mildew opens the way for further injury to the pods and seeds by other fungi, so that quickly following its prime development there appear such fungi as *Fusarium*, *Alternaria*, *Cladosporium*, etc. The growths of these eventually discolor the pure white of the mildew.

The attack of the fungus on the flowers is not usually very conspicuous, though it is through insect visitation to these, as shown by Sturgis, that the infection of the young pods often takes place. So, too, the leaves, petioles and vines are generally not much injured and apparently are infected only

in their young state. The infected leaves often show an irregular injury of the tissues with more or less of a purplish discoloration, especially on the veins, and there is no very evident growth of the fungus showing on them. See Plate XXI, b.

Financial loss. In this state a few Lima beans are usually grown by each farmer for home consumption and most gardeners grow the pole varieties in quantities for the market. They are probably raised most extensively around New Haven, though each large city has more or less grown in its vicinity. The largest grower in the state, A. N. Farnham of Westville, often plants twelve or more acres and sometimes most of these are in a single large field. The financial loss due to injury by the mildew comes chiefly on the market gardeners and is greatest in those localities where the beans are grown extensively. Thaxter's statement, based on his observations at Hamden, that the mildew "bids fair to become the most serious obstacle yet encountered in the cultivation of this vegetable," especially in the Atlantic seaboard states, was not exaggerated. Sturgis wrote that "during the summer of 1897 the conditions were such that in many places the effects of the fungus have been most disastrous." In 1898, in a number of counts in a certain field, he found that the percentage of pods attacked by the mildew varied from 36 to 53 per cent. of the total number produced during the season. The writer's observations on the disease began in 1902, when the fungus did considerable damage, especially in the lower, more moist places in the fields. During the next two years there was comparatively little injury, but in 1905 the loss caused by it was the greatest since 1897. In one of the largest fields in the state, the grower estimated that the yield was cut down about one-third by this pest.

Halsted (4) states that the mildew was so serious in New Jersey in 1897 that "few or no pods were picked from some of the fields." He also reports numerous complaints of it in that state in 1902. Smith (12) records the mildew as injurious in Delaware in 1903; and Woods in a letter to the writer states that, in Frederick county, Maryland, in 1905, "it is said to have destroyed from 25 to 90 per cent. of the crop."

Relation to weather. The prevalence of most parasitic fungi is largely influenced by the character of the weather, particularly in regard to moisture. This is especially true of the

downy mildews. An abundance of rainy or cloudy weather at certain periods of the year determine whether or not these troubles will be injurious. July, August, and to a less degree September, are the months in which unusual moisture develops the downy mildew of the Lima bean, just as it does the downy mildew, or blight, of the potato. So far as yet ascertained, the middle of July is the earliest that the Lima bean mildew has been found in this state and frequently it does not appear until the middle of August. After its appearance it can be found more or less abundant, according to the weather, up to the time the vines die. Halsted (6) notes the fungus as late as October 24 on green pods, after the leaves had been killed by frost, and the past year the writer collected it in several fields on October 4 under the same conditions. Sturgis reports, however, that in 1897 "for some reason not wholly clear, perhaps because of lessened insect activity, the mildew ceased spreading about September 10th."

From the published data it seems quite certain that trouble from the mildew may generally be expected in very moist years. Halsted (5), writing on this point, says: "The year 1897 had its counterpart in that of 1889. During the past ten years there have been in the Eastern States two Julys noted for their excess of rainfall (1889 and 1897). . . . In connection with what has been said above concerning the influence of copious rainfall upon the unusual development of the potato rot, it is in order to report that another member of the genus *Phytophthora* [the Lima bean mildew] has been complained of bitterly during the season of 1897. . . . Particular emphasis is placed upon the date of the discovery [1889] and the fact that it was very abundant at the time it was taken, because that was the year in which the three months of July, August and September gave a total rainfall of 27.33 inches for New Jersey and presumably as wet in Connecticut; which is 9.54 inches more than the average of those three months for the past ten years." Besides in 1889 and 1897, the mildew was unusually abundant in 1902, which year was characterized by cold damp weather in July and August, and again in 1905, which though dry previous to the middle of August was rather moist the remainder of the month and during the first part of September.

The middle Atlantic seaboard states apparently offer the best conditions for the development of the fungus, and as it has spread into most of these, there may be expected increasing trouble from the pest in their market garden districts in years with very moist weather during July or August. Not many Lima beans are grown in New England north of Connecticut. In the drier middle and western states less injury may be expected should the fungus become introduced, except possibly in localities affected, as to moisture, by the Great Lakes.

Methods of distribution. The means by which the fungus spreads over the vines after it once gets started in a field and presumably by which it is carried to some extent from one field to another, have been discussed somewhat in detail by Sturgis. He found that both insects and wind were important agents in its distribution. Rains also aid greatly by washing the spores from the infected parts over the same plant.

Concerning insects as agents of distribution, we quote from Sturgis (15) as follows:

"The occurrence of the mildew on the pods at a very early stage of their growth, led to the supposition that insects were responsible in a measure for the spread of the fungus. Examination of the flowers served to confirm this supposition, and a few words regarding the structure of the bean flower will explain how infection takes place. The conspicuous portions of the bean flower consist of an upright petal known as the standard; two narrower petals, distinct, projecting forward below the standard and known as the wings; and two petals in the form of a closed, spirally coiled tube occupying a position between the standard and the wings, and called the keel. (Fig. 8,¹) At the base of the keel is the ovary or young pod surrounded by the stamens and prolonged upwards into the style. The long stamens and style are completely enclosed in and protected by the keel. Under such conditions cross-fertilization would seem to be impossible, especially as the pollen is shed abundantly from the anthers which are borne upon the stamens in close proximity to the upper portion of the style, and neither the stigma nor the anthers appear beyond the end of the tube in which they are enclosed. But the wings form a convenient resting place for visiting bees in search of nectar, and in case a bee lights upon them his weight deflects them and at the same time draws the keel down and backward, thus causing the stigma and the hairy portion of the style covered with pollen to protrude from the mouth of the tube. (Figs. 8,²,³) As the insect plunges his head into the flower, the stigma and pollen-laden style come into contact with his abdomen and cross-fertilization is assured by subsequent visits to other flowers. But fungous infection is

assured with hardly less certainty, provided the bee has previously had contact with the spores of the fungus. In that case we should expect to find the first attack of the fungus at the two points where the bee, in his search for nectar, touched the more moist and delicate tissues of the flower; viz. on the style and at the base of the ovary or pod. A large number of flowers was examined and this supposition was

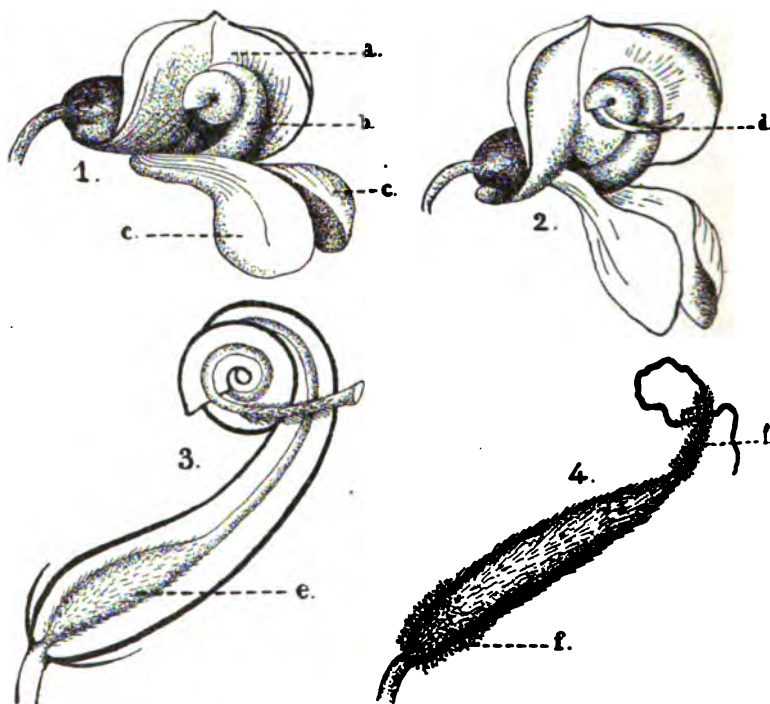


Fig. 8. Showing details of bean blossom with reference to infection with mildew by bees. 1. Parts of blossom: a. standard, b. keel, c. wings. 2. Showing how the weight of a bee alighting on the wings causes protrusion of style, d. 3. An enlarged keel in cross-section, showing enclosed pistil with young ovary or pod at its base, e. 4. Pistil showing growths of mildew (f.) at base and apex of the young pod resulting from spore inoculation by bee visitation during blossoming period. (1-2 after Gray; 3-4 after Sturgis.)

strikingly confirmed. The mildew was found in many of the flowers, and in every case it occurred on the spots above mentioned and nowhere else. (Fig. 8,*) It seems certain, therefore, that the spread of this mildew is largely due to the agency of insects, particularly of bees, and this view is further confirmed by the fact that in the case of young pods the mildew almost always appears first at the base or tip and very rarely in the middle."

The influence of wind on the distribution of the fungus in a field is shown by the following account, also quoted from Sturgis:

"The Lima beans on the Station grounds are on high land composed of a light sandy soil, and have never been affected with mildew. The rows run east and west. Directly south of them at a distance of about one hundred feet, but separated from them by a pile of lumber and a few trees, are two rows of bush Limas running north and south. On August 14th, when the mildew had been abundant in the neighborhood for a month or more, the Station vines were examined and found to be entirely free from the fungus. A few mildewed pods were brought from a distance, and the spores from one of them were rubbed and dusted on the surface of a sound and nearly ripe pod at the east end of each row of the pole Limas. Within a few days the mildew made its appearance on the infected pods, and from this point of vantage, the prevailing winds at the time being from the northeast and north, it swept down both rows and in two weeks the whole patch was completely mildewed. The spores had also been carried over a distance of one hundred feet to the bush Limas, and the mildew, beginning at the north end of the rows, that is, at the point nearest to the pole beans, spread rapidly down the rows. It

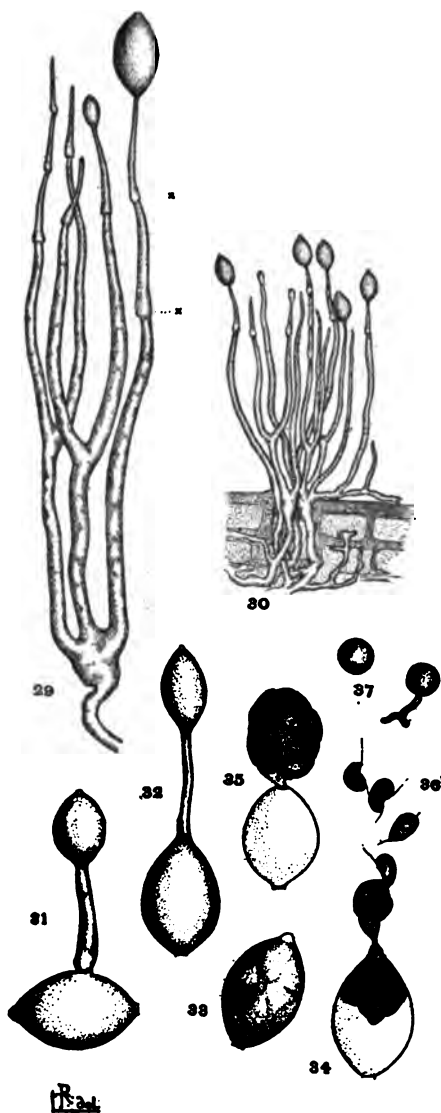


FIG. 9. Details of conidial stage.
(After Thaxter.)

is evident then, that spores placed upon the surface of a sound Lima bean pod were enabled to start the disease, which thereupon spread with great rapidity in the direction of the prevailing wind."

Microscopic structure. Having considered the more general character of the fungus and its environmental factors, let us proceed to a study of its minute structure as revealed by the microscope. For a preliminary account we can do no better than to give Thaxter's (19) description:

"Examination of a section of the diseased tissue shows it to be penetrated by the irregular branching hyphae of the fungus [*mycelium*] which run between the cells and, collecting in the air spaces beneath the breathing pores, push out through them into the air (Fig. 9, ²⁰) in such numbers that the latter are completely obliterated. These hyphae (Fig. 9, ²⁰), just at their point of exit from the breathing pores, are usually slightly swollen and give rise to one or more branches [*conidiophores*] which grow almost vertically into the air, and, taken together, produce the white woolly appearance already mentioned as characteristic of the disease. These vertical branches may themselves be once dichotomously branched, that is give rise to two branches, forming a more or less symmetrical fork; while at their tips they swell out into the large, terminal, oval *conidial spores* represented in the figure. A peculiarity of the genus *Phytophthora* consists in the fact that after a spore has been produced at the apex of a hypha, the hypha continues to grow at the point where the spore is attached, pushing it to one side if it has not already fallen off, and soon swelling into another spore. This may be repeated several times, the points where spores have been previously formed being marked by successive vesicular swellings (Fig. 9, ²¹)."

The *mycelium* is similar to that usually formed by the downy mildews. Its hyaline threads, Plate XX, 1-6, are more or less branched, are occasionally somewhat irregular in shape and have a comparatively thin cell wall which on staining with chloroidide of zinc shows the presence of cellulose. They are chiefly 5-7 μ or occasionally even 9 μ in diameter. The contents at first completely fill the threads and consist of a very homogeneous protoplasm, or this may also contain numerous oil globules of varying size. As the threads advance in their growth they often become empty in their older parts and also rarely develop septa with the recession of the protoplasm. The writer has not studied the special haustorial branches that push directly into the cells in search for food, and Thaxter simply states that the mycelial hyphae rarely penetrate the cells of the host by irregular haustoria.

The *conidiophores* of this mildew are much longer than those produced by the potato mildew. In the figures shown here from Thaxter, Fig. 9, ^{29, 30}, the young conidiophores have not reached their full length. In fact they usually become so long and lax that they form an interwoven mat rather than erect distinct threads. They also differ from the conidiophores of the potato mildew (which give off two to several simple branches along the apical third of their length) in that they are simple or more rarely dichotomously branched, usually near their base. Some conidiophores were found having over a dozen swollen nodes, thus indicating the formation of as many spores, but usually they have less than half a dozen, which may be scattered or grouped toward the terminal end. Occasionally it is difficult to detect any nodal swellings on a thread. From these statements it is seen that the conidiophores are not so differentiated into spore-bearing organs as in the potato mildew. For this reason it is hard to tell whether the white matted growth that covers the exterior of the pods is composed entirely of conidiophores or partly of mycelium from which the conidiophores develop. The latter, however, are often found growing directly from the stomates in clusters which sometimes contain a dozen individuals but more frequently about half that many. Thaxter does not give the length of the conidiophores and it is difficult in the old matted growths to separate out single ones for measurements. Specimens were measured that varied from 300 to 475 μ but these were probably not extreme lengths. In an examination of artificial cultures, one fruiting thread that was traced measured over 1200 μ in length. The diameter of the conidiophores is usually about 5 or 6 μ , rarely 8.5 μ , at their lower end, and they taper to about 2.5 or 3 μ at the apical extremity. The swollen nodes generally vary from 4 to 6 μ in width. At first the conidiophores are filled with protoplasm, but as spore production proceeds their contents are limited to the distal end and finally they may become entirely empty. Their walls are thicker than those of the mycelial threads and give a stronger reaction in the test for cellulose, as do also the spore walls. Very rarely septa are seen in the empty conidiophores.

The *conidia*, or spores, of the Lima bean mildew, Fig. 9, ^{29, 33}, are similar to those of the potato mildew, but larger. The

spores of the latter vary from 17 to 35μ in length by 11 to 20μ in width, while those of the Lima bean mildew are chiefly 28 to 42μ in length by 17 to 27μ in width, and Thaxter records some even 50μ in length. They are hyaline, elliptical to chiefly ovoid in shape or rarely even broadly ovoid to subspherical. The papilla of dehiscence is very evident at their apical end, and when shed from the conidiophores the basal end is usually marked by a short hyphal plug showing the point of detachment. Protoplasmic contents fill the spores usually without special differentiation, though sometimes at germination faint areolations appear.

Germination of spores. The spores do not germinate readily unless perfectly fresh. The germination of such spores placed in a drop of water in a Van Tiegham cell takes place in a few hours and can be easily watched under the microscope. Thaxter's excellent description of their germination is as follows:

"The germination takes place in two ways. In the one case a single hypha of germination is produced, which may enter the host plant directly or give rise to another, or secondary spore like itself (Fig. 9, ^a, ^b) which germinates in its turn like the ordinary conidia. In the second case, which is by far the most common, the content of the spore becomes very faintly lobular, as shown in Fig. 9, ^c and suddenly and rapidly begins to make its exit, through the ruptured apex of the spore, Fig. 9, ^d in the form of a continuous chain of spindle-shaped bodies, consisting of naked protoplasm; the orifice alternately expanding and contracting as each body is, as it were, squeezed out by the pressure from within. In some cases the whole content of the spore makes its exit thus, the chain winding itself into a round or oval mass above the apex of the conidium as in Fig. 9, ^e. Usually, however, the chain breaks in the course of its discharge and almost instantly a rapid motion begins, at the point of separation, which draws the spindle-shaped bodies successively apart. The motion is due to a slender thread or cilium, drawn out by the pulling apart of the narrow zone connecting two adjacent bodies, and the rapid vibration of this thread gives rise to the motion just mentioned. The spindle-shaped bodies, as soon as they are free, move irregularly for a moment, changing their shape the while, till they become contracted, the two extremities being drawn together on one side towards a small clear spot, usually present in bodies of this nature, so that in one view the outline is slightly crescent or bean-shaped (Fig. 9, ^f). After or during this change of shape the motion of the cilia becomes very rapid, and the bodies, which are known as *zoospores*, dart away in the surrounding water. After swarming for a certain time, usually about half an hour, the *zoospores* come to rest, assume a

spherical shape, swell considerably, become surrounded by a thin cell wall and very soon begin to germinate (Fig. 9, "f") by giving rise to a hypha which makes its way into the tissues of the host plant, thus infecting it with the disease. The whole process, owing to the minute size of the zoospores which are less than $\frac{1}{10,000}$ of an inch in diameter, may take place upon the moist surface of a leaf or other portion of the host plant, the thinnest pellicle of water being sufficiently deep for them to swim in. The usual number of zoospores formed from spores of average size is about fifteen, so that each spore may give rise to fifteen distinct points of infection."

Perpetuation of the fungus. The zoospores just described are very short lived, lasting so far as known but a few hours. The conidial spores, too, are of a temporary nature, retaining their power of germination but a comparatively short time even under favorable conditions and in dry weather perishing in a few days or even hours. The conidiophores and mycelium are more persistent, but as the Lima bean is an annual it is impossible for the mycelium to live over the winter (except in the seeds) as a dormant parasite. It may be thought, possibly, that the mycelium survives in the rubbish of the diseased beans and in the spring as a saprophyte gives rise to the conidial spores. This, however, is contrary to the known habits of the downy mildews and against all evidence that the writer can find after a careful examination of this species. Invariably the Lima bean mildew suffers in development by the decay of the infected pods and is at a decided disadvantage in competition with bacteria and saprophytic fungi that follow in its wake. So far as observed, it then gradually ceases to form conidial spores and fails entirely to spread further, at least in this spore stage. If the mycelium does develop as a saprophyte, which we doubt, it would most likely produce an entirely different kind of spores—the oospores.

Sturgis made some observations and experiments to determine if the mildew survived the winter in the refuse of a mildewed crop by means of "resting spores, a perennial mycelium or any other form." In his search through such material that had been kept out doors over winter he failed to find "any trace of a vegetative or reproductive body which could be even remotely associated with the *Phytophthora* causing the mildew." Seeds taken from this refuse and planted all rotted but one, which produced a perfectly healthy plant. The refuse was used

as a mulch on ground at the Experiment Station and planted with Lima beans, but the beans came up through the mulch without apparent infection and remained free from the mildew until near the close of the season, when some did appear. In judging of the results of this experiment one must remember that Sturgis found no sign of oospores in the refuse he used and presumably they did not occur in it abundantly if at all. The writer, however, has found them recently under similar conditions though mostly in poor shape due to attack of other fungi on them before they were matured. It must be taken into account, too, that the mildew did appear on these beans toward the end of the season, but possibly it was brought in by insects, though the Experiment Station grounds are far from any other place where Lima beans are commonly grown and the mildew has rarely appeared on beans planted there. Sturgis evidently considered the experiment largely a failure because "diseased plants" were not produced from diseased seed and because the mildew did not appear out of season and in abundance from primary infections.

In a preceding paragraph it was stated that as the Lima bean was an annual plant it was impossible for the parasitic mycelium to be carried over from one year to another by it except in the seeds. We believe this is sometimes done and in the report of the Station for 1903, p. 308, expressed the belief that it was the ordinary way the fungus perpetuated itself. From our examinations of the past year we now know positively that the mycelium does often penetrate from the pods into the seeds. If the pod is badly diseased the seeds are destroyed, or at least injured so they will not germinate, by this and other fungi that follow it. There are, however, probably all gradations between seeds destroyed and those in which the mildew barely gains entrance. Experiments made by the writer go to show that diseased seeds that germinate do not produce "diseased plants"; that is, the mycelium does not pass from the seed into the young plant and produce a conspicuously injured plant from which the fungus is eventually spread by conidial spores to other plants. There is reason, however, for believing that the dormant mycelium may be carried over the winter in the seeds (just as is the potato mildew in the tubers) and that on the living tissue of the

seed when planted it may form a few of its conidial spores (as can the potato mildew on the cut surface of the seed tuber) or that possibly in some cases a delayed production of the oospores takes place in the cotyledons. In either case the writer believes that the primary infection of the plants takes place by the germination of the conidial spores or the oospores into zoospores and these latter infect the parts of the plant brought into contact with them in the moist earth. That the mycelium is sometimes present in apparently sound seed is shown by the following case, in which nearly matured seeds were taken from diseased pods in the fall and placed in a damp chamber on moist cotton. These seeds were taken away from the diseased part of the pods and to the naked eye showed no sign of disease or evidence of the mildew. Yet in less than a week some of them were developing abundance of oospores in their tissues and some few had a slight conidial development on the outside. The only point not determined was how long the mycelium would have lived had the seeds been dried out; or in other words, if it could have passed the winter in them and then have gone through the same development when they were planted in the ground in the spring.

Mention has been made several times of *oospores*. Such spores are of an entirely different character from the temporary conidial spores. They are thick-walled and are usually produced by the mycelium within the tissues of the host. They do not, as a rule, germinate when formed but are for the purpose of carrying the fungus over the unfavorable winter period and on germinating the next season produce the primary infections of their hosts. Oospores are characteristic of the downy mildews, but until discovered recently by the writer were not known for the Lima bean mildew. Let us now pass to a consideration of this stage of the fungus.

OOSPORES, OR WINTER STAGE.

Where and when found. Although Thaxter, Sturgis and the writer made especial search for the oospores they escaped notice until September, 1905, at which time the mildew was unusually abundant in the region of New Haven. There may be two reasons why the oospores were not found before; namely, either they did not occur commonly or they were

not looked for at the proper place and time. The latter reason more likely explains the failures to find them. Judging from the experience of the past year, the oospores should be looked for toward the end of the season and in the *seeds* of the pods badly infected with the mildew. Sturgis searched especially for them in the pods and the decaying rubbish. The writer also looked for them chiefly in these places and in fact actually collected pods in 1902 which a recent examination shows had immature oospores in the seeds that escaped detection. Not all of the seeds from infected pods contain oospores and there is no sure way of determining whether they are present or not except by microscopical examination. Often after the mycelium of the downy mildew penetrates from the pods into the seeds, the mycelia of other fungi, especially that of *Fusarium*, develop so abundantly as to seriously interfere with the further growth of the *Phytophthora*. Frequently, too, the mycelia of these other fungi form the more conspicuous growth both outside and inside of the seeds. Plate XXI, a, shows in the lower row several dried seeds, containing oospores, that were taken from badly mildewed pods. So far the oospores have been found in the seed coats and cotyledons of the seeds and to a limited extent in the tissues of the pods, but not in the leaves or the stems.

If the oospores generally occur only in those seasons when the mildew is unusually abundant, it has occurred to the writer that this might be explained on the supposition that there exist two mycelial strains of the fungus, possibly sexual in nature, and that the production of oospores can only result when these strains occur together on the same pods. Naturally a season very favorable for the spread of the fungus would multiply the chances of these occurring together. This idea of distinct mycelial strains is discussed further in this report in the following article dealing with the potato downy mildew, where are given the writer's reasons for believing that such strains may exist among the downy mildews, as has recently been demonstrated for the related family of the *Mucoraceae*.

Description of oogonia, etc. The downy mildews, or the *Peronosporae* as they are called scientifically, have a characteristic oosporic stage which has been observed for many of the species and is supposed to exist for all. One of the chief

functions of these spores is to carry the fungus over the unfavorable winter period. The oospores differ essentially in structure from the temporary conidial spores in that, as resting spores, they have thick walls, and are formed singly inside a special envelope called the *oogonium*, and further differ from them in origin in that they are the result of the conjugation of differentiated sexual branches of the mycelium developing usually within the tissues of the host. The male cell of the mycelium is known as the *antheridium* and after its contents are emptied into the special female cell, the *oosphere* (immature oospore), it often withers away.

The characters of the oogonia, oospores and antheridia of the Lima bean mildew, as found by the writer, are as follows: Oogonia (Plate XX, 22-25) inter- or intracellular in seed coats or cotyledons of seeds, occasionally in tissues of pods and more rarely imbedded in mycelium on surface of seeds and pods, with rather thin scarcely folded walls loosely enclosing oospore, at first hyaline or slightly tinted but finally reddish brown, subspherical, chiefly $23-38\mu$ in diameter. Oospores (Plate XX, 22-25) spherical or sometimes subspherical, with apparently smooth and moderately thick walls ($2.5-4\mu$, chiefly 3μ in thickness), hyaline or light yellowish, $18-26\mu$, chiefly $19.5-22.5\mu$ in diameter. Antheridia (Plate XX, 8, 9, 12-17b) temporary, hyaline, variable, sometimes irregular but chiefly ovoid to ovate, usually applied to oogonia near their place of attachment to the mycelium, chiefly $8.5-11.5\mu$ in width by $14-17\mu$ in length.

Development of oogonia, etc. It is not easy to make out exactly the stages of development of the oogonia even from living material. This is because the mycelium forms a matted growth within the tissues, often obscuring details. The very general notes given here were obtained partly by teasing into fine bits pieces of the seeds known to contain oospores and examining this material under the microscope and partly from microscopic examination of cultures of the fungus grown on artificial media in test-tubes, though some fixed and stained sections were also prepared for examination. No attempt was made to study the cytological phenomena. Apparently when the oospores are to be formed the mycelium becomes more abundant and is often crowded into matted growths of threads

which are more variable and irregular in shape than normally. The mature oospores, therefore, are likely to occur more thickly in certain places rather than to be scattered uniformly in the tissues or cultures. So far as could be determined the antheridia and oogonia are developed on distinct mycelial threads. It was not possible to trace these threads far, as the mycelium by the tearing apart is more or less torn, but also it becomes less distinct on the differentiation of these organs, through loss of contents. These fertile threads possibly ultimately have origin on a common mycelium, but more probably they represent distinct mycelial strains mixed together whose combined presence is necessary for the production of oospores. The writer is inclined to the latter view, but was unable to determine any very distinctive characters by which an antheridial developing mycelium can be told from that bearing oogonia, if such really exist. Very often the mycelial threads had swollen places in them (Plate XX, 4) as if these might be tentative antheridia but which because of the absence of oogonial contact had run out again into threads, perhaps developing similar swelling further on. It seemed to be true, however, that the antheridia are not usually entirely differentiated on the thread until after contact with the oogonium. Likewise there were not found many isolated young swollen cells that represented the early stages of the oogonia. From this one would expect that, if there be distinct strains, their mycelia would not show, when grown separately, any development of antheridia or oogonian but would both form conidiophores. This would agree with DeBary's statement that, "In all known Peronosporae and Saprolegniae the antheridia are not formed until after the extremity of the branch which supports them, and from which they are afterward separated by a septum, has attached itself to the oogonium and this attachment takes places in the early stage of both organs."

In a preceding paragraph the mature antheridia were described. They are formed as a swollen cell (Plate XX, 12b) at the end of a mycelial thread or a short mycelial branch as circumstances determine, so that there are no characteristic antheridial threads. A basal septum (Plate XX, 14b) soon separates the swollen end of the mycelial thread into a distinct terminal cell, the walls of which remain thin. Usually the contents of the

antheridia did not seem to be so sharply marked off from the cell wall as those of the oogonia, often appearing empty because of this lack of contrast. This was probably because oil drops are not so prominent a constituent as in the oogonia. Often after the antheridia are cut off the threads bearing them are empty of contents and difficult to trace any distance. Some of the antheridia showed, when isolated from the oogonium, a prominent protuberance (Plate XX, 8) but nothing was seen like a distinct fertilization tube which penetrated into the oogonium and through which the contents were emptied into it, as has been described for some species.

The oogonium also starts as a swelling (Plate XX, 10c) at the end of a mycelial thread or a short branch or in some cases is intercalary. It gradually enlarges and assumes a subspherical shape. It is thin-walled, filled with protoplasm and oil drops, and after emptying the thread from which it originates of the contents is separated from this by a septum (Plate XX, 13c). Usually before the oogonium has reached large size a young antheridial branch has reached it and the antheridium is formed at the base of the oogonium, that is, where it is joined to the mycelial thread. Soon after the application of the antheridium the oogonium reaches full size and a further step in its development appears in the transfer of its principal contents into a central denser mass, the *ooplasm* (Plate XX, 15, 16), which a less conspicuous marginal *periplasm* surrounds. This central ooplasmic body is soon further marked off by the formation of a thin limiting wall and is then known as the *oosphere* (Plate XX, 19). Though not observed, presumably by this time the antheridial contents have passed into the oosphere by means of a fertilization tube. From now on the contents of the oosphere show changes of development the character and sequence of which were not definitely made out. At the same time the wall of the oogonium becomes slightly thicker and eventually has a reddish brown tint. The periplasm does not seem to be prominent but probably assists in the formation of the wall of the oospore. This gradually thickens until 2.5 or 3 μ thick (Plate XX, 22) and is uniform, smooth hyaline or slightly yellowish tinted and consists of a single evident layer, but outside of this the periplasm apparently forms an amorphous envelope which probably serves as a protection

against absorption of water out of season. A large oil drop often occupies the center of the mature oospore and this is surrounded by a dense uniform layer of protoplasm. The oogonial wall permanently invests the mature oospore (Plate XX, 23, 24) as a loose envelope, but all signs of the antheridium are often obliterated by this time.

Germination of oospores. The germination of the oospores was tried several times, but they have failed to germinate up to the first of April of the year following their development. The germination of spores in pure cultures left out-doors during the greater part of the winter will be tried later, since they too failed to germinate as early as April.

Artificial cultures. This is the first time the downy mildew of Lima beans has been reported as grown in artificial cultures, and apparently the first report of the production of oospores of any mildew in cultures of this character. The writer has grown the downy mildew of the potato in artificial cultures during the past two years and even previous to this two French botanists had published accounts of its growth under similar conditions. The downy mildew of tobacco is said to have been grown in the same way. Apparently these three fungi, all belonging to the genus *Phytophthora*, are the only species of the *Peronosporae* that have been grown in this manner.

The vigorous development of the Lima bean mildew in the fall of 1905 suggested that perhaps it could be grown on various media under control in the laboratory, as had been done with the potato mildew. As certain precautions are necessary to secure growths, a short account of the methods are given. In the first place a culture cannot be obtained by transference of spore material to a test tube from a growth on the pods. This is because of sure contamination with other fungi or bacteria which will stop or seriously interfere with the development of the comparatively slow-growing mildew. Neither can cultures be obtained from the spores by the Petrie dish separation method, because of their slow growth and more natural germination by zoospores instead of by germ tubes. The best method for securing pure cultures is to transfer into the culture tubes pieces of the tissue, or better whole seeds, which contain mycelium of the fungus, taking these from the interior of pods showing the freshest and least contaminated external growth of the

mildew. Care should be taken in breaking or cutting open the pods and a sterilized knife or forceps are necessary to remove the tissue or seeds from the interior. The first attempts seemed to indicate that cultures could be easily obtained in this way but later experience showed that many of these became impure with age. Other fungi, especial *Fusarium*, closely follow the development of the mildew, and unless seeds or tissues in a very early stage of infection are selected some mycelium of these or bacteria will also be included and eventually spoil the cultures.

In the test tube cultures the following media were used: (1) Living beans on moist cotton. These cultures were obtained in two ways. (a) Beans were taken with aseptic precautions from diseased pods and placed in the test tubes. As these beans were usually already inoculated with the mycelium penetrating into them from the pod, the subsequent development of the fungus could be determined by examination from time to time. (b) Beans were removed from perfectly healthy pods with the same aseptic care and after placing in the test tubes were inoculated with a culture of the fungus or tissue from a diseased bean. The beans, especially the (a) cultures, usually formed a more or less evident, though not luxuriant, external growth of the conidial stage, but the greatest development was in the production of oospores within the tissues. The beans generally turned reddish brown, indicating enzymal action, and in some cases there was practically no external growth of the conidial stage. Plate XXI, a*, shows a bean artificially infected in which oospores were produced abundantly but on which practically no conidial growth occurred; at a** is shown a perfectly healthy bean. Most of the successful cultures were made on these living beans, as there was less interference from bacteria and other fungi when the cultures were impure. (2) Sterilized bean tissues, of which the following combinations were tried; (a) whole beans on moist cotton, (b) a mixture of ground green beans and pods, and (c) a combination of (b) the corn meal. These were fairly good media, but bacteria, yeasts and fungi bothered considerably if they were not inoculated with perfectly pure material. Both the conidial and the oogonial stages are formed. (3) Agar agar, usually made with (a) potato juice water but in some cases (b) with sugar, and peptone and certain salts. The mildew developed poorly

in most of these trials, but both conidia and oogonia occurred to some extent. (4) Corn meal which was made up with (a) potato juice, (b) peptone, sugar and certain salts, and (c) ground beans and pods. Corn meal is a good medium when once the fungus gets started, and in these trials also both stages occurred. Because of oogonial production the fungus did not penetrate as deeply into the medium as expected.

Cultures of the mildew were kept going from the middle of September to the middle of November. At first there was a more luxuriant growth of the conidial stage than toward the end of the period and finally this stage seemed to so run out that it was practically impossible to continue cultures. At all times it was easier to start cultures from inoculated tissue than from tufts of the fungus transferred by needle from one tube to another. There was required, too, a certain degree of moisture in the culture to insure the best growth. By far the best results were obtained on the living bean cultures. Fungi, bacteria and yeast bothered considerably, especially on the sterilized media. It was very difficult to get cultures that did not finally develop such impurities, though a number of these were obtained. The growths of the Lima bean mildew were in marked contrast with those obtained of the potato mildew in that the development of the conidiophores was inconspicuous while the reverse is true in nature. No doubt the formation of oospores greatly interferes with the conidial development, and if this latter could have been secured alone, as it was with the potato mildew, a much more luxuriant external growth would have been made. One of the most interesting questions connected with the cultures of these two mildews is why in one case oospores were always produced and never in the other. This question is discussed more fully in the following article on the potato mildew.

PREVENTIVE MEASURES.

From the preceding discussion one can see that there are certain conditions that favor the introduction and spread of the mildew in the Lima bean fields. Some of these factors can be controlled, at least to a certain extent, by the grower. In the following paragraphs are given briefly the means by which he may hope to prevent or lessen the injury inflicted by this parasite.

Selection of seed. It has been shown how the dormant mycelium and the oospores carry the fungus over from one year to another in the seed. If possible, therefore, the seed should be gathered from a field entirely free from the disease. Where this is impossible a very careful selection should be made from pods that show no sign of the mildew and from these only the best and least shriveled should be used.

Rotation. It will do no good to select disease-free seed if this is planted on land that bore a diseased crop the year before, as the old seed rotting in the soil will probably furnish oospores for infection. Each year the beans should be planted on a different piece of ground, so that three or four years pass before it is again used for this crop. This is a practice not always followed, as one large grower in the state, at least, has planted beans year after year on the same land and his beans are sure to be attacked by the mildew if any are that year.

Destruction of rubbish. Where rotation is faithfully followed each year perhaps little good will be accomplished by destroying the old vines, as the oospores probably will not live in the ground more than a year or two. Where, however, the grower deems it very essential to use the same land the next year for Lima beans, the chances for infection will probably be lessened by gathering and burning in the fall all of the rubbish of the old crop. It should be borne in mind in this work that the pods and seeds are the parts it is most necessary to destroy.

Methods of planting, etc. The Lima beans are usually planted to climb upright poles and these are set in rows to allow cultivation in one direction. They should be set a sufficient distance apart in the rows (say three to three and a half feet) and the rows should be of sufficient width (about four and a half feet) to allow free entrance of the sunshine to dry off the foliage and prevent the enclosed air from being too damp. Neither should more than two or three vines be grown to a pole for the same reason. Low moist spots in the field favor the first infections and the spread of the mildew afterwards, so it is desirable if such exist to plant some other crop on these spots. So, too, considering injury from the mildew only, it is more advantageous to use a high dry field than a lower more moist one.

Spraying. Sturgis is the only investigator who has reported spraying experiments for the prevention of this mildew. His

first experiments were made in 1893 with a number of fungicides, but as the mildew did not appear in this field even on unsprayed vines no conclusions could be drawn, except that the fungicides did not injury the foliage in any case. In 1897 he made further trials using Bordeaux mixture, ammoniacal solution of copper carbonate, potassium sulphide, and sulphur as the fungicides. The best results were obtained with a row that was sprayed three times with Bordeaux and twice with Amm. Sol. Cop. Car., as this yielded 296 marketable pods against 25 on an adjacent unsprayed row. Sturgis says, "The conclusion to be drawn from this experiment is that even in a season most favorable to the Lima bean mildew, thorough treatments of the vines with the Bordeaux mixture will ensure a crop."

While the writer has conducted no spraying experiments for the prevention of this mildew, he has watched certain fields in the vicinity of New Haven that have been sprayed. From these observations and the results of Sturgis' work the following suggestions are offered: Spraying need not be commenced before the middle of July, or possibly in very wet seasons about the first of this month. Bordeaux mixture is the most satisfactory fungicide and in later sprayings need not be replaced by Ammo. Sol. of Cop. Car. or potassium sulphide if the marketable pods are picked before each spraying. Even if some sediment does still adhere to the pods when picked, this can do no possible injury unless prejudice militates against their sale. The spray should be directed chiefly to the young parts of the vines and should be delivered in a fine mist. It is most important that the spray reach the pods and least important that the foliage be covered. Three or four thorough sprayings with Bordeaux mixture will probably be sufficient for most seasons. Most of the spraying observed by the writer has been partially ineffectual because it was done too early in the season and because the leaves were the parts chiefly protected.

Factors beyond control. Season is the chief factor in determining the amount of injury by the mildew. As stated before, very wet weather from July to September is favorable for the development of the trouble. Of course the weather can not be controlled, but where one has taken the preceding precautions his loss should be much less than one who has not. A

second factor not under control is insect visitation. As shown by Sturgis, bees may spread the disease in a field and we have reason to believe that they may carry it to a certain extent from one field to another. This being the case, one who makes the preceding precautions to keep the disease out of his field should also isolate it, as far as possible, from other fields, especially from those that are likely to be seriously troubled. Where the fields are very close together not only insects but also the wind may help to carry the disease from one to another.

EXSICCATI.

Specimens of the Lima bean mildew have been issued in the following exsiccati, all the specimens having been collected in the vicinity of New Haven on *Phaseolus lunatus*: Seym. & Earle Eco. Fungi, 9 (Thaxter, Sept. Oct., 1889); Ellis & Ev. N. A. F., 2707 (Thaxter, Sept., 1890); Bri. & Car. Fung. Par., 351 (Rorer, Sept., 1901); Ell. Ev. Barth. Fungi Col., 1949 (Clinton, Aug. 29, 1902).

LITERATURE.

The following references to the literature of this mildew include all of any importance that the writer has been able to find. Even some of these contain only data taken from Thaxter and Sturgis.

1. **Berlese, A. N.** *Phytophthora Phaseoli* Thaxt. Riv. Pat. Veg., 9: 41-4. 1902.
Gives scientific description and general notes on this fungus, which he lists only from New Haven, Conn., drawing his data from Thaxter and Sturgis.
2. **Briosi, G. and Cavara, F.** *Phytophthora Phaseoli* Thaxt. Fung. Par. No. 351. [Illustr.]
Issue specimens from New Haven collected by Rorer and give figures and descriptions taken from Thaxter.
3. **Clinton, G. P.** Downy Mildew, *Phytophthora Phaseoli* Thaxt. Ann. Rep. Conn. Agr. Exp. Stat., 1903: 307-8. 1904. [Illustr.]
Gives short general account of the fungus and suggestions for its prevention.
4. **Halsted, B. D.** Notes upon Mildew of Lima Beans. Ann. Rep. N. J. Agr. Exp. Stat., 1897: 297-9. 1898. [Illustr.]
Reports this very serious in Bergen Co., N. J., in 1897; mildew worst on low land that had Lima beans on it the year before.

5. **Halstead, B. D.** The Phytophthora of Lima Beans. Bull. Torr. Bot. Club, 25: 161-2. 1898. [Illustr.]
Notes this fungus as serious in New Jersey in 1897, which was a wet season.
6. **Halsted, B. D.** Late Growth of Bean Mildew—*Phytophthora Phaseoli* Thaxt. Bull. Torr. Bot. Club, 26: 20. 1899.
Notes late growth of the fungus, Oct. 24, on the green pods after the leaves had been killed by frost.
7. **Halsted, B. D.** The Downy Mildew of Lima Beans. Bull. N. J. Agr. Exp. Stat., 151: 18-24. 1901. [Illustr.]
Gives a general account of this fungus, which has proved a serious trouble of Lima beans in New Jersey in wet seasons.
8. **Halsted, B. D.** The Mildew of Lima Beans. Ann. Rep. N. J. Agr. Exp. Stat., 1902: 399-403. 1903. [Illustr.]
Reports troublesome in New Jersey in 1902 and gives extracts concerning it from Bull. 151 of the New Jersey Station.
9. **Jaczewski, A. de.** *Phytophthora Phaseoli*. Bull. Torr. Bot. Club, 29: 649. 1902.
Salmon quotes portions of a letter from above botanist, who notes presence of this fungus in Russia.
10. **Orton, W. A.** *Phytophthora Phaseoli* Thaxt. Yearbook U. S. Dep. Agr., 1903: 554. *Ibid.*, 1904: 584.
Lists the fungus as injurious in Connecticut, New Jersey and Delaware in 1903; but in 1904 it is reported only from New Jersey.
11. **Saccardo, P. A.** *Phytophthora Phaseoli* Thaxt. Sacc. Syll. Fung., 9: 341. 1891.
Gives scientific description taken from Thaxter and lists only from New Haven, Conn.
12. **Smith, C. O.** Mildew of Lima Bean. Bull. Dela. Agr. Exp., 63: 23-4. 1904.
Deals briefly with this fungus and notes its appearance in Delaware from July on in 1903.
13. **Speschnew, N. N.** Les parasites vegetaux de la Cakhétie. Arb. Bot. Gart. Tiflis, lief. 2, 1897. [Review: Zeitsch. Pflanzenk., 11: 113.]
Lists *Phytophthora Phaseoli* Thaxt. from the Gouv. Tiflis (Kaukasus).
14. **Sturgis, W. C.** Mildew of Lima Beans. Ann. Rept. Conn. Agr. Exp. Stat., 1893: 77. 1894.
Used several fungicides but as the fungus was not present in the sprayed field their value was not determined.
15. **Sturgis, W. C.** The Mildew of Lima Beans (*Phytophthora Phaseoli* Thaxt.). Ann. Rep. Conn. Agr. Exp. Stat., 1897: 159-66. 1898. [Illustr.]
Gives a general account of the fungus and shows how bees spread the fungus to the flowers; gives results of successful spraying experiments with Bordeaux mixture, etc.

16. **Sturgis, W. C.** On some aspects of Vegetable Pathology and the Conditions which influence the Dissemination of Plant Diseases. Bot. Gaz., 25: 191-4. 1898. [Illustr.]
Shows how insects and wind are influential in the spread of *Phytophthora Phaseoli*.
17. **Sturgis, W. C.** Mildew of Lima Beans. Ann. Rep. Conn. Agr. Exp. Stat., 1898: 236-41. 1899.
Made experiments to determine effect of thin and thick planting an upright and slanting poles on amount of mildew, which was very bad this season; looked especially for means by which it carried over winter in old rubbish but found nothing.
18. **Thaxter, R.** A new American *Phytophthora*. Bot. Gaz., 14: 273-4. 1889.
Gives a general and a scientific description of this new species, *Phytophthora Phaseoli* Thaxt.
19. **Thaxter, R.** Mildew of Lima Beans (*Phytophthora Phaseoli* Thaxt.). Ann. Rep. Conn. Agr. Exp. Stat., 1889: 167-71. 1890. [Illustr.]
Includes a general description of the fungus, an account of its germination, its relation to other species and methods for its prevention.
20. **Thaxter, R.** Mildew of Lima Beans. Ann. Rep. Conn. Agr. Exp. Stat., 1890: 97-8. 1891.
Notes distribution of fungus in Connecticut, especially during this year.
21. **Thaxter, R.** *Phytophthora Phaseoli* Thaxt. Journ. Myc., 7: 279. 1893.
Gives scientific description and references to literature of this fungus.

DOWNY MILDEW, OR BLIGHT, *Phytophthora infestans* (Mont.) DeBy., OF POTATOES. II.

In the Report of this Station for 1904 the writer gave the first installment of his work with the potato blight. This included a short general account of the life history of the fungus, so far as known, and of spraying experiments looking toward the most practical methods for controlling the disease. The investigations of the past year, reported in this article, have been made chiefly to determine more minutely and accurately points in the life history of the fungus in the hope that when this is definitely and completely known, prevention of its ravages will be an easier task to those who take advantage of this knowledge. The points that need especial elucidation are the way or ways by which the fungus *first* infects the vines in the summer (that is the primary infections), its history, if any, in the soil, and the means by which it is carried over from year to year. To gain such information the writer made careful observations of the very first appearance of the disease in various fields, examined the plants and tubers in all conditions of health and decay, carried on indoor inoculation experiments and grew the fungus in artificial culture for two years. We are not yet satisfied with what is known of the fungus and hope later to make additional reports concerning it.

PRIMARY INFECTIONS.

Diseased plants. What conditions do the very first infections of the year in a given region or field require? We know that the disease has never appeared, or at least has never been recorded, in Connecticut before the first week of July, and sometimes it is not found before the middle of August, and that the more rainy, cloudy and foggy these months are the quicker it gets a start and the more rapidly it spreads. Smith and DeBary also report that the blight is seldom seen in Europe before July or August, though rarely it has been found even in May or June. The common belief, or at least the one advocated by DeBary concerning the advent of the fungus in a field, is that it comes from "diseased plants."

Perhaps DeBary's (2) views can be best shown by the following quotation: "The facts which have been observed estab-

lish that there are two methods by which the conidia may pass from the tuber to the foliage. *First*, it is known that the mycelium of the fungus in the tuber, even when in the ground, is able to produce conidiophores bearing conidia directly from the tuber. We can easily see how the conidia thus produced could reach the foliage—they might be carried up either by the growing plant which may have touched them, or by small animals which frequent both situations. Neither of these methods can be easily detected. Moreover, the formation of conidia in the soil cannot be very frequent. There should therefore perhaps be little weight attached to this method. The *second* method can be easily observed and with great exactness. It consists in the mycelium growing from the tubers in and with the young plants and producing conidia on them in the usual way; and these [diseased plants!] of course extend the fungus to the healthy plants beside them. In 1861 I called attention to the fact that tubers containing *Phytophthora* when they are growing, not unfrequently send out shoots into which the fungus passes from the tubers. The fungus advancing slowly in its growth at last kills the shoots, which for the most part were always in a sickly condition. The same tubers, as is known, may also send out healthy shoots at the same time. I further showed that under special circumstances the fungus in these diseased shoots develops conidia. These were not conjectures, but facts observed in experiments. The observations, however, were not made in the open field, but in the house and laboratory, and had not been confirmed by myself or observed by others in the open field." DeBary tried to demonstrate this second theory by planting tubers he infected through the eyes outdoors along with healthy ones, and observing if, upon the growth of the plants, the disease spread to the leaves of all the plants. In his first trial, although he grew a diseased plant, the fungus never fruited on this and so did not spread the disease. In the second trial the healthy and diseased tubers were planted out early in the garden in a box and several diseased shoots appeared which in time developed a fruiting condition of the fungus, so that before the end of May the blight had spread to many of the leaves of all of the plants. This was long before its appearance elsewhere in the neighborhood.

The writer, thinking that DeBary's "diseased plants" might offer the best explanation of the first appearance of the blight, made special search for them in different fields after the vines were above ground at various times up to the general appearance of the disease, but was not successful in finding such plants. True, one sometimes finds plants stunted by the bacterial stem rot and also those with cankered areas on the parts below ground caused by the *Rhizoctonia* fungus, but no sign of any disease like or unlike these containing outbreaks of the blight fungus. For two or three years efforts also have been made in the greenhouse to produce blight diseased plants from tubers known to contain the mycelium of the blight fungus. The badly diseased tubers often failed entirely to grow; others, less diseased, produced plants, sometimes making a poorer growth than usual, but never showing any signs of the blight. Thinking that possibly the greenhouse conditions were not favorable for determining this point, as the atmosphere there was usually rather dry, a more extended experiment was conducted outdoors in the spring of 1905. Through the kindness of some thirty Connecticut potato growers who had suffered from rot of tubers in 1904, a few potatoes showing disease were obtained from each. While these growers were requested especially for tubers showing the reddish superficial rot characteristic of blight, the potatoes sent showed the *Rhizoctonia*, scab, and *Fusarium* rot troubles as much or more than they did the blight. The tubers were divided into five lots and planted in five rows, as follows: (1) tubers freest from disease, also treated with formalin; (2) same as (1) but not treated; (3) tubers badly scabbed; (4) tubers with abundance of *Rhizoctonia*; (5) tubers with *Fusarium* or blight rots, or both. In the last case some of the tubers were badly rotted and the plants in this row came up somewhat slower and less uniformly than in the others, but there were no blight diseased plants seen at any time and the first blight that appeared was on leaves of a plant in the row whose tubers had been selected as freest from disease and then treated with formalin! Neither did the tubers produce any more rot in the fifth row than those in the other rows, while the row of scabby tubers produced a crop badly scabbed and the *Rhizoctonia* row one with that trouble very prominent. Other experimenters (Smith, DeBary) have also reported cases

in which perfectly sound plants were grown from blight-diseased tubers.

The only instance in which the writer has seen anything like a blight-diseased plant, as recorded by DeBary, was in the greenhouse, where a healthy tuber, planted in a crock with the top just above the surface of the soil, was inoculated with the blight fungus on one of the young buds, which was then covered with moist cotton and a small bell jar. This bud was finally killed and the reddish brown rot of the blight extended in time down into the tissues of the tuber about a quarter of an inch and spread for some distance beneath the skin, reaching another eye from which eventually was grown a stem several inches long. This stem, see Plate XXIV, b, about thirty or forty days after the inoculation showed a reddish brown discoloration on the exterior from the base to the tip and the conidial spores of the blight fungus were produced sparingly upon it. The interior tissues of the stem, however, seemed to be perfectly healthy and free from the fungus, and so if the disease came from the mycelium in the tuber growing up into the stem, this growth occurred in the external tissues rather than through the bundles, as one might expect. There was a possibility, even in this case, that the disease was inoculated externally by lice carrying spores from the inoculated place on the tuber, since perfectly healthy stems grew out of the sides of this diseased one. So far as the writer can judge from reports in literature and his own experience, *DeBary's "diseased plant" method of primary infection does not seem to have sufficient support so far to justify the belief that it is the common method in nature.*

Contact of leaves with ground. But if the blight does not generally first spread from a diseased plant, how does it start in a field? There is offered here an explanation which our observations of the past year seem to indicate as the ordinary method of infection. Possibly this idea has been advanced before, since the writer has not carefully examined the literature to determine this point. In support of our observations that the blight does not usually start from diseased plants, let us first quote the following from Smith (6, p. 293): "It is obvious that if the potato disease is annually reproduced by diseased tubers containing perennial mycelium, the disease must invariably begin in the seed tuber and ascend the stem; but it is known

by experience that in the vast majority of instances this is not the case, but that the disease first invades the leaves." This corresponds with our observations of the past summer; namely, that the disease first appeared on a few leaflets, often on the outermost leaves, of the fully grown, perfectly healthy plants. and these conditions of its appearance preclude the belief that the disease came by the mycelium in the diseased tubers ascending the stems and growing out into the leaves, all without causing any injury or evidence of its presence until finally it produced the characteristic black spots on the isolated leaflets! But Smith does not state definitely how the disease came on the leaflets in these cases. We believe it comes *by contact of the leaves with the ground at the critical wet periods of July and August when the germs of the blight are probably first generally available in the soil for infection, and that this is the usual method of primary infections in the fields.*

In support of the preceding statement we give the following evidence: The season of 1905 was dry during midsummer, so the blight was backward in its appearance. A number of fields, chiefly in the vicinity of New Haven, were examined from time to time to note the very first signs of blight. Weather favorable for this trouble came on about August 9th to the 16th and the first blighted leaves found anywhere, August 11th, were in an isolated field at Southington that had not been examined before. This field of two or three acres had been in potatoes the year before but was greener and in a better condition than many fields at this time, as the drought and other agents had been very injurious. After a careful search of the field the attempt to find any blighted leaves was about to be given up when two plants near together were found on which a dozen leaflets showed a single blight spot each. *Two of these leaflets were still in contact with the moist ground and half of the others showed by the dirt on them that they had recently been in contact with the soil.* Of course it is possible that some of these spots may have come from secondary infections, as the fungus was already fruiting on these leaves. There was no sign of a diseased plant in the field so far as observed and certainly none in the vicinity of the outbreak, and an examination of the two plants having the diseased leaflets showed no sign of the fungus on their stems. The later development of the blight in this

field was not observed. The second place where the blight was found was on August 12th, in the small isolated plot at the Experiment Station, previously mentioned, where the blight showing different kinds of disease were planted. In this case they were in sod land that had not been in potatoes before. The plot was carefully watched, so that a diseased plant could not have escaped observation. Here, too, no such plant occurred and the blight first appeared on a healthy plant which had about ten leaflets with single blight spots, in fruiting condition when found. Two of these leaflets were still in contact with the soil and two thirds of them showed dirt on their upper surface, indicating recent contact with it. There were no breaks anywhere on the stem of this plant or even on the stem below the ground so far as could be observed. The blight afterward gradually appeared throughout the plot. The first case found was in an isolated field of half an acre in Wallingford, by which the writer often passed and stopped to look for the blight. This was first found August 16th, when a careful search a plant was discovered with a single leaf showing the blight. While this leaf was then off from the ground, dirt on its under side again showed recent contact with the soil. A photograph of this leaf is shown in Plate XXIII, a; on the other side a badly diseased leaflet was producing conidial spores. No other blight was found on any other part of the plant, though the field was looked for carefully. In a second place in the field, but removed from this, another plant was found with several blight spots on the leaves, some of which were still in contact with the ground. Here the blight had spread, in some cases, from the blades to the pedicles and petioles, but these were always near the blight spots and all of the petioles were perfectly free from the blight at their base. There was again absolutely no sign of the blight on the stem of the plant. Later the blight gradually spread over the field. Other fields examined up to this time had no blight, but by the 22d of August it was found appearing generally in a number, so that from this time on the blight was not uncommon in fields still green.

Planting potatoes without rotation. It is not an uncommon practice for farmers in this state to grow potatoes two consecutive years on the same land and there is at least one field in the vicinity of New Haven that has had potatoes on it for several

years in succession. While the writer has not yet determined from his own observations whether the fungus can carry over the winter in the old tubers in the soil, Massee (3) of England makes the following very definite statement: "I have observed the important fact that, when the diseased potatoes are planted, after the crop has been lifted, the remains of the old seed potatoes when brought to the surface of the ground will produce a crop of the fungus bearing myriads of spores. If such old seed potatoes are kept buried in soil until the following year and then exposed to light, under favorable conditions, fungus fruit is still produced, and continues to grow so long as a scrap of the old potato remains. I have now in the laboratory at Kew Gardens scraps of last year's seed potatoes covered with the fungus, and with the spores thus produced have successfully inoculated the leaves of young potato plants." If Massee's statement is true, then fields used two years in succession should, as a rule, develop the blight earlier and spread it more rapidly than fields not in potatoes before for some time. As the writer knew of three fields which had produced a badly diseased crop the year before and were used again last year for potatoes, these were examined to see if this was so. The one most carefully watched was in Westville and had abundant rotten tubers from the preceding crop left on it. In this case, however, the vines were practically dead before any blight appeared in the neighborhood, so that all that could be determined was that its use a second year did not cause an unusually early appearance of blight in it. The other two fields were at Green's Farms and so could not be watched so closely. When first examined on August 19th they both showed blight more prominently than other fields in the neighborhood. This was especially true of the earlier plant field, in which the blight was very prominent, while another field on the same farm isolated from this, but on land not in potatoes for years, was at this time practically free from blight—only a single blighted leaf being found there. On August 28th at Hamden a fourth field was examined that was said to have had potatoes on it several years in succession, and this showed more blight in it than had been seen in any field up to that time in the vicinity of New Haven. Other fields examined generally showed an earlier or a more vigorous start of the blight if they had been in pota-

toes the year before. *We do not wish to state positively, from these observations, that the blight starts earlier and more vigorously in a field that bore a blight-diseased crop the year before, as such factors as situation of the land, earliness of planting, etc., may need consideration here, but so far as they go they seem to point to this conclusion.*

SECONDARY INFECTIONS.

By secondary infections are meant all those that take place from and after the original infections (the outbreaks on a diseased plant, if such exists, or on leaves infected from contact with the ground), and thus generally spread the disease to the leaves of these plants, to those throughout the field or even to other fields. The means cited here (rain, wind, and insects) have usually been considered agents for the distribution of the blight spores, though few special observations have been published showing them to be such or indicating how far the disease may be carried by them. To determine these points more fully the following observations and experiments were made the past year.

Rain. The testimony of all who have written concerning blight shows that rainy or moist, muggy weather is absolutely essential to the development and spread of blight in the fields. This is especially necessary for this fungus because the spores on germination usually form swimming spores, *zoospores*, which are the common agents of infection. Not only is moist weather necessary for infection, but dry bright weather following the infection largely stops the spread and even the development of the fungus already within the leaves. The moist blackened tissues then dry up, and though the disease may seem to have suddenly caused great damage, it is not progressing into the healthy green tissues beyond as it would have done had the weather remained moist. Rain not only induces the formation and germination of the spores, but it serves as an agent in distributing them over the infected plants and also washes them down into the soil to the tubers. It can not of course be of much service in carrying spores from one plant to another unless they overlap, and therefore by itself could only very slowly spread the disease throughout a field if there had been but a single starting point.

Wind. It is not so easy to prove that wind serves as a means of distribution, but it no doubt acts as a carrying agent of the spores to vines in the same field or to fields situated closely together. The fungus, however, is not especially adapted for dispersal by the wind, since the spores are borne on the under side of the leaves and on the whole are not produced in great abundance. The dry winds of bright weather would be of little value, as it is in such weather that the spores rapidly lose their power of germination and would find least opportunity for germination, even if carried into a field. It does not seem likely, therefore, that wind is a common agent in carrying the spores from one isolated field to another. The case cited in a previous paragraph—the field the second year in potatoes at Green's Farms in which blight developed vigorously and early—seems to indicate that wind may be a prominent agent of dispersal for short distances, since the prevailing winds were from the direction of the infected field toward an adjoining one, which also soon became infected with the blight.

Insects. Apparently insects are a common agent in the distribution of the spores throughout a field, and the chief means of conveying them from one field to another somewhat remote. In other words, if it were not for insects, the selection of an isolated field which had not been used recently for growing potatoes and which was planted with tubers free from the disease should give a crop exempt from blight. The most common insects in the potato fields of Connecticut are the flea beetle and the common potato bug, or Colorado beetle. The latter is well adapted for carrying spores, since the under side of the tarsi of the legs, especially the third tarsus, is provided with a stiff brush of hairs that would easily retain spores temporarily as the insect crawled over an infected leaf. The only insect examined to determine this point did not actually have the spores of the blight fungus on the brushes of hairs, but these did have spores of other fungi, showing they could serve such a purpose. The soft, somewhat moist body of the larvae of the potato beetle, too, possibly aids in distributing the spores. Just how helpful to the fungus the flea beetles are in this work is not known.

To determine whether insects could carry the blight from one isolated field to another, an experiment was conducted last

year at Mr. Burr's place near Green's Farms. The potatoes were planted in a garden on soil that had not contained potatoes for at least five years. The garden was isolated and well surrounded by trees, etc., and was not situated so that wind would blow from another field toward it. The nearest potatoes were at least an eighth of a mile away and the badly diseased field mentioned before, about half a mile. The seed tubers were obtained from Colorado on the recommendation of Mr. Orton of the Division of Vegetable Pathology of Washington that this was a region of the United States exempt from blight. So far as could be learned, the grower of these potatoes had never been troubled with this disease and Professor Paddock of the Colorado Experiment Station writes that he has never identified the blight in that state. These potatoes were examined the same time, August 19th, that the writer looked through the other fields on Mr. Burr's farm. After a searching examination a couple of leaves showing the blight were found, and Mr. Burr wrote in the fall that eventually these potatoes suffered from the blight about as badly as the others. Without much question the potato bug was the means of introducing spores for the first infection, after which the blight spread from this throughout the plot. Part of the Colorado potatoes were planted on land not recently in potatoes, but very close to the badly blighted field mentioned before, and these on August 19th showed considerable blight on the leaves. Both the wind and insects were no doubt the carrying agents here. Some potato seed was also obtained from this Colorado grower and planted in the greenhouse during the winter and the young seedlings set out later on the Experiment Station grounds about five rods from ordinary garden potatoes. These seedlings, too, became infected with the blight, but not until sometime after it appeared on the garden potatoes. The potato bug was again the most probable carrying agent. From this experience, the writer concludes that *the grower can not depend upon isolation of a field and absolute freedom of soil and tubers from the fungus to secure a crop free from blight since insects are very likely to carry in the disease, though the more isolated the field the less likelihood of infection.* Such conditions, however, will insure a later appearance of the blight in the field, but whether retarding the invasion will prove of any practical value

will depend upon how long the infection is delayed and the weather conditions thereafter.

ARTIFICIAL INFECTIONS.

By this is meant indoor infections produced by the writer, chiefly with pure artificial cultures of the blight fungus. To secure infection it is necessary that the cultures be in fresh spore-producing condition and that the inoculated plants be kept moist or in a moist atmosphere, not only during the infection period, but also afterwards if the fungus is expected to appear in its fruiting stage on the surface of the infected parts. The few experiments tried were made to determine how easily infection takes place under different conditions and how soon the conidial stage appears after the spores are applied. Both leaves and tubers were used as subjects for infection.

With the leaves. DeBary showed that the germ tubes of the zoospores of potato blight can enter the leaves either through the stomates or by penetrating directly through the epidermis. The usual method in the latter case is for the germ tube to push its way down between the walls where two cells come together and then grow down into the intercellular spaces of the leaf beneath, but DeBary also observed cases in which the germ tubes bored directly into the epidermal cells themselves. The ability of the fungus to gain entrance in these various ways greatly aids its spread over its hosts. The stomates are more numerous on the under surface of the leaf, but most of the infections probably take place from the upper surface, as the spores are most likely to be carried here from the conidiophores borne on the under surface of leaves above.

In our infection experiments after the spores were placed on the upper surface of the young leaves, usually by the end of three days it could be determined if the inoculation was successful by the slight discoloration of the tissues. By the end of the fourth day this discoloration was more evident and conidiophores were beginning to protude through the stomates, and by the end of the fifth day the diseased spot was well marked and a few mature conidiophores and conidial spores were present. As these spores can germinate immediately, secondary infections could take place within five days after the primary. Perhaps the development of the fungus can be shown

best by a detailed account of the infection of the plant shown in Plate XXIV, a, which was photographed ten days after the spores were applied. Its history is as follows: *January 11th*, placed spores in water on three lower leaves, covered each with a small piece of moist cotton and the plant with a small bell jar. *January 14th* (3 days), the two lower leaves showed slight discoloration at points where spores were placed. *January 16th* (5 days), the spots were well marked and conidiophores and spores were formed in small numbers. *January 18th* (7 days), about two thirds of the two lower leaves were plainly diseased (yellowish, limp and partly blackened) and the conidiophores were developing over the greater part of this area, but most abundantly on lower surface; two diseased streaks showed on the stem but had few conidiophores on them; petiole of one leaf was covered with conidiophores, but showed little discoloration. *January 21st* (10 days, see illustration), the two lower leaves were dead and hanging limp; the third leaf showed yellowish discoloration over apical half and was producing conidiophores; the fourth leaf (apparently a secondary inoculation by lice) had a few conidiophores on it, but no injury to its tissues showed as yet; several blackish streaks showed on the stem where the fungus had gained a foothold from the diseased leaves above.

With the tubers. There are a number of different conditions under which inoculation of the living tissues of the tubers may be tried; namely, on the cut surface in a moist atmosphere, on various uninjured parts (eyes, buds, skin) before or after removal of the tuber from the plant, or on these same places after mechanical injury to them. In the experience of the writer the development of the fungus varies greatly under these dissimilar conditions. It grows most luxuriantly, at least externally, on the cut surface of the tuber in a moist atmosphere. Before inoculation it is always desirable to soak the whole tuber in a 2 per cent. formalin bath for half an hour and to use a sterilized knife in cutting it, in order to limit as much as possible the development of other fungi and bacteria which easily crowd out the *Phytophthora*. Discoloration of the tissues, at least for some time, does not follow the development of the fungus on the cut surface of the tuber; this probably indicates very superficial penetration into the tissues.

DeBary states that he secured infection of the tubers very readily through the terminal eyes. Presumably the buds were slightly developed in the tubers he used. Our experiments, at least, seemed to indicate that it is very much easier to secure successful inoculation through the very young buds than it is at the eyes of a perfectly dormant tuber in which no bud is yet evident. These experiments, too, go to show that inoculations on the uninjured skin of a dormant tuber are not likely to be successful, while at the same spot if the skin is first injured by a knife puncture the inoculation succeeds. Likewise, in the single experiment tried, the inoculations were not very successful on the uninjured skin of very young tubers still attached to the plant, and scarcely more so when the tissues were injured before inoculation. Possibly some of these results were partly due to the age of the cultures used, but even then there seems to be no doubt that there is greater variability and difficulty in securing infection of the tubers than of the leaves.

Three of these inoculation experiments with the tubers are recorded here: 1, *November 19th*, tried to inoculate five dormant tubers, using artificial cultures of the blight. Each tuber was buried in the soil of a crock so that a single lateral, deeply indented eye, showing no sign of bud formation, was exposed above the surface of the soil. These uninjured eyes served as a cavity into which the spores and water were placed, when they were then covered with watch crystals lined with moist paper to retain the moisture. The tubers, however, were so thoroughly seasoned that the water in the eyes was rapidly absorbed and had to be replaced many times during the next few days, though the soil around the tubers was also kept moist. Possibly this drying out influenced the result, for not a single inoculation was effective, and at the end of 32 days the tubers were still perfectly sound at these eyes. 2, *December 21st*, used the same tubers but placed the spores away from the eyes on a small spot where the skin had been injured by a knife. On examination ten days later rots showed at all of the points of puncture. Some of these were the characteristic dry reddish brown rot of the *Phytophthora*, with or without the conidiphores showing slightly at the punctured point, while in other cases bacteria were also agents of the decay. January 9th one of the tubers was half rotted and a short shoot from it had been

killed by *Phytophthora* and bacteria, having, apparently, become inoculated externally by lice. February 21st, took up all of the tubers and the plants that had developed from them. All of the seed tubers were entirely rotted, showing more or less of the characteristic reddish brown dry rot of the *Phytophthora*, especially near the outside, but all but one had produced plants and small tubers. None of these new tubers showed any sign of rot; neither were any of the plants diseased. Cross sections of the stems close to the old seed tubers and of the underground shoots running from these to the new tubers in no case showed any sign that the mycelium of the blight fungus had passed or was passing from the diseased tubers into these. 3, February 21st, inoculated four young tubers (about one inch in diameter, growing in greenhouse bench) with culture of the blight fungus,—two with and two without injury to tissues. February 23d the injured spots showed evident but very slight rot, while the uninjured showed doubtful start. March 20th the injured spots had rotted but little, being only $\frac{1}{4}$ of an inch in diameter and extending but slightly into the flesh; while the uninjured spots were only about $\frac{1}{8}$ of an inch in diameter and still more superficial. The fungus did not fruit at any of these places and bacteria may have been partially responsible for the rot, though in the case of the check tuber, injured but not inoculated, no rot appeared.

ARTIFICIAL CULTURES.

So far as known to the writer, the reports of Matruchot and Molliard (4, 5) made in 1900 and 1903 are the only ones so published concerning pure artificial cultures of the blight fungus. The work reported here was begun in the fall of before learning of the investigations of these French botanists and has been carried on now for about two years. Growing the fungus on various media in test-tubes was undertaken chiefly to see if this would not throw some new light on the life history of the fungus, especially with regard to the oospores. The general results obtained agree with those of the French investigators, though the details of the media used were not altogether the same.

How obtained. Pure cultures of the blight fungus are so easily obtained as are those of many fungi, since

their slow growth they are easily crowded out in competition with other fungi, and because the ordinary Petrie dish separation method is not available with their spores, which prefer a fluid medium for germination. Matruchot and Molliard apparently made most of their cultures by exposing the cut surface of an infected tuber in a moist chamber until the fungus ran out on this in its fruiting stage, when material from the growth was transferred by a sterilized needle to test tubes containing various media. Such growths on the tubers are nearly always contaminated and usually only a few of the cultures made from them remain pure. If the tubers are first sterilized on the outside by a bath in formalin and cut with a sterilized knife, better results will be obtained. It is desirable, too, if possible, to use only tubers showing a superficial decay of the *Phytophthora* rot. On the whole, the writer was most successful in obtaining cultures when the reddish brown diseased tissue from the interior of a tuber next the healthy tissue was removed in small pieces, about a third of an inch in diameter, by a sterilized knife and then inserted on the medium in the test tube. In this case the mycelium from the diseased tissue in time runs out onto the medium and often produces a pure growth of the fungus. Where infected tubers are not available for cultural work, the fungus can be started on the freshly cut surface of a sterilized tuber by suspending over it a leaflet containing a vigorous, fresh outbreak of the blight. The spores falling on the cut surface soon start a growth of the fungus, from which material may be transferred to the test tubes. Here, too, contaminations usually prevail in spite of precautions. Plate XXIII, b, shows a nearly pure growth of the fungus started in this way. One of the most common fungous interlopers is a species of *Fusarium* and it is often impossible to distinguish between the growths of this and the *Phytophthora* and they soon become intermingled. Microscopical examination is usually necessary to determine which part of the growth on the cut surface of the potato presents the blight fungus in a pure condition.

Media, appearance, etc. Altogether twenty-five to thirty different cultural media and modifications of the same medium were tried to determine the most satisfactory ones and also to see if the fungus could be induced, under different conditions, to develop any unknown stage. These media fall in four gen-

eral classes, viz., 1. Plugs of living plant tissue, 2. Sterilized plant products, 3. Agar agar media, 4. Earth and manure. The results are discussed briefly in the following paragraphs.

1. The writer found, as did Matruchot and Molliard, that plugs of living tissue taken with antiseptic precautions from the interior of a potato, and to a less extent from the pumpkin, offered a very favorable medium for the growth of the fungus. These plugs were cut from the interior of a sterilized tuber with a knife, which had been sterilized with heat and allowed to cool so as not to sear the tissue, and after slicing off the sides a second time were placed in the test tubes on a sterilized cushion of cotton saturated with water. With proper care these plugs can usually be obtained free from organisms and if the atmosphere of the tube is kept sufficiently moist upon inoculation the mildew forms a very favorable growth. This is more or less luxuriant, apparently, according to the conditions of moisture and the success with which the original infection took place. Sometimes a scanty growth of normal conidiophores producing numerous spores occurs or again a conspicuous pure white felt develops, of which a large part is made up of mycelial threads. Plate XXV, a, shows (b) a rather scanty and (c) a very luxuriant growth of the fungus, (a) being a check or uninoculated tube. On the other hand, similar plugs taken from the sweet potato, apple, and cucumber gave practically no growths.

2. Sterilized corn meal properly mixed with water was the best medium used. The chief difficulty lies in inoculating these tubes, as the top of the corn meal usually dries out in a short time into a hard mass and this may prevent the fungus getting a proper start. On the other hand, the mechanical conditions allow the fungus, when once started, to gradually work down toward the more moist base of the tube. To facilitate inoculations and removal of tufts of the fungus, it is best to have the corn meal in a slant at its upper end. Plate XXV, b, shows a growth of the mildew on corn meal, of the same age as those shown on the potato plugs. In the few trials made, a mixture of ground green Lima bean pods and seeds with corn meal gave very satisfactory growths and probably this medium without the corn meal would do as well. Sterilized potato plugs, however, gave scarcely any growth, and according to Matruchot

and Molliard this is due to the mechanical interference of the swollen starch grains in preventing the spread of the fungus.

3. Agar agar cultures, with various ingredients added, were tried, but on the whole were less satisfactory than the preceding media. Most of these cultures gave slight growths, while, in all, the fungus was slow in developing. Usually a slight growth of the mycelium penetrated the medium and a more or less conspicuous development of conidiophores and mycelium was formed on the surface. Potato and pumpkin juice agar media were as satisfactory as any tried. Plate XXV, c, shows an old culture on pumpkin juice agar, in which the development was more prominent than usually obtained on agar media.

4. Sterilized manure, earth, mixtures of these and of these with other ingredients were used to a limited extent to see if they would furnish proper media for the development of the fungus. It was thought that if this was the case there might be some ground for believing that the fungus made some such development in nature. In all of these trials the growths made were very slight or there was none at all. The very poor growths noticed were due, in some cases, to the medium added with the fungus on inoculation. So far as could be learned from these cultures there is no reason for believing that the fungus makes any unknown growth in the soil.

Results. These investigations showed that the fungus can be grown in artificial cultures rather readily under favorable conditions. The cultures can be kept alive for some time, especially on a medium, as corn meal, allowing the fungus to spread slowly through it. By occasional re-inoculations the fungus, apparently, can be kept indefinitely in culture. In some cultures and under some conditions, there is a more luxuriant development of the fungus than in others. The most conspicuous growths usually indicate a more vigorous mycelial than conidial development. No sign of an oogonial or other unknown stage appeared in any of the cultures. In one case, however, there was a very slight growth from the pieces of an infected tuber inserted in agar tubes and in this medium some peculiar swollen bodies were formed whose nature was not definitely determined. They resembled somewhat the immature so-called oospores that Smorawski (7) has figured. A few cross inoculations were tried with cultures obtained from different sources, but nothing

different mycelial strains might be discovered whose growth together would result in the production of oospores. As the different cultures were few in number and were obtained chiefly from the same vicinity, but during two different years, it is not desirable to draw even a negative conclusion from the results.

PERPETUATION OF THE FUNGUS.

The known vegetative and reproductive states of downy mildews in general are mycelium, conidial spores, zoospores and oospores. The conidial spores and zoospores are so short lived that these fungi, so far as known, have to depend on the mycelium and oospores to carry them over the unfavorable winter period. In the following paragraphs is discussed how the potato blight is, or possibly may be, perpetuated.

Dormant mycelium in tubers. So far, this is the only way in which it is positively known that the fungus survives the winter. The disease caused by its presence in the tuber does not need to be conspicuous, and in fact the more diseased the tuber the less capable this is of germinating and so, presumably, the less likely it will be of perpetuating the mildew. The fungus may be present in the tuber and yet escape notice, as the rot is sometimes very superficial and slight; in fact DeBary records a case where the fungus grew out on the cut surface of a tuber he was using for an experiment on the supposition that it was entirely free from the fungus. This being true, it is doubtful if much good would result where tubers were selected to avoid diseased ones, though it is not advisable, of course, to use those showing a superficial or even deep-seated reddish brown dry rot. The mycelium in the tubers seems to be much less active in the spring than when the tubers are first dug. Ordinarily in the fall if the cut surface of a diseased tuber is exposed in a damp chamber the fungus will spread more or less over this surface. On the other hand, of the thirty samples obtained from Connecticut growers and tested in this way in the spring, the fungus developed on only two lots, yet most of those tried had the appearance of blight tubers. This decreased activity or vigor of the fungus is apparently due to the drying out of the tissues of the tuber, which induces a hibernating condition of

the mycelium, and in some instances where the tubers have been stored in unusually dry places no doubt the mycelium does not survive.

Two views are advanced to explain how the mycelium in the infected tubers planted in the spring perpetuates the fungus. First, by growing up from the tuber into the stem, it produces a "diseased plant." This view has been previously discussed in the paper. We believe that the mycelium rarely passes up into the plants in this way, and just as rarely passes down from the plants after infection into the new tubers, as was formerly believed by some investigators. Second, the mycelium forms the conidial stage on the cut surface of the tubers or rarely in tufts through punctures in the skin, and the conidial spores or their zoospores, on being carried to the buds of the tuber or later to older parts, cause infection. The chief objection to this view is that infection in this way probably could only take place during a short time in the spring (the writer's and DeBary's experience indicates that the mycelium forms the conidial spores only on the living and not on the badly diseased tissue of the tubers) whereas the first visible outbreaks, so far as known, do not appear until July or August. Could it be possible that owing to the rapid growth of the young plants these primary infections remain isolated in the tissues and do not develop further until the growth of the host ceases and favorable blight weather appears?

Heterœcism. This means that a fungus has different stages of its development on different hosts, as is the case of the wheat rust with two stages on barberry plants and later two more on wheat. DeBary, who first demonstrated this life cycle of the wheat rust, has discussed the possibility of the potato mildew being heterœcious. He concluded that there was no likelihood of this being so, though at one time false rumors stated he had found a different stage on another host. There are absolutely no data in favor of such a supposition for the potato mildew and no evidence of heterœcism has ever been found for any of the downy mildews.

Unknown stages. Various writers, often to support some theory, have suggested possible or probable stages of the potato mildew, not known for other downy mildews, but no real evidence of their existence has yet been produced. For instance,

Smith (6, p. 292) writes: "It is not unreasonable to imagine that some other condition of the parasite, at present quite unknown to and unsuspected by us, might be brought to light. The fungus may exist in inconceivably fine dust-like particles or in the condition of a mucous fluid." This was an entirely theoretical suggestion, but a Scotchman, A. S. Wilson (8), advocated a more definite unknown stage. His theory was as follows: 'Certain bodies were found on the under side of leaves, in all parts of the stem, especially at the nodes, and in the tubers, especially around the eyes. These he originally called sclerotiets (analogous to sclerotia) but later named them granules of mucoplasm. They are translucent, microscopic globular bodies coated with oxalate of lime. His observations caused him to believe that these, on germination, gave rise to the mycelium of the potato mildew and that thus the disease could break out on any part of the host without translocation. As the resting spores are not parasitic but live and germinate in the soil or in any dead matter, it is contact with the mucoplasm exuded from their fresh mycelium which originates the parasitism in the potato. As the tubers are infected, especially at the eyes, with mucoplasm granules, the general elements of the parasite are carried over from one race of potatoes to the following and from one season and country to another, not requiring invasion from without for a new display of the disease.' This is apparently a case where there is too much theory and too little exact observation and no experimentation to back it.

Oospores. These are thick-walled sexual spores often produced by the downy mildews and constitute the common means by which they are carried over from one season to another. Several investigators claim to have found these spores for the downy mildew of potato, but in no case have they produced sufficient evidence to satisfy botanists in general of their reality. Different suggestions have been advanced to account for the absence or rarity of these spores, and these, briefly summarized, are as follows: 1. That the oospores have never existed for the potato mildew. 2. That this mildew has lost the power to produce these bodies. 3. That they may occur only in certain regions of the world. 4. That they are produced only in certain hosts,—the potato mildew having been found on a number

of other plants. 5. That they are formed in the potato more as a saprophyte than as a parasite. 6. That possibly these spores are formed only on the union of distinct mycelial strains which do not commonly occur together—a suggestion by the author.

The more the writer looks into this matter the more he is inclined to believe that oospores of the potato mildew do exist, especially since he has recently demonstrated their presence for the closely related species occurring on the Lima bean. Therefore, so far as he is concerned, the first two suggestions given above may be dismissed as unsatisfactory. Those persons who suggest special regions where the oospores may be found name Chili, the original home of the potato, as a possible locality or region where the genus *Solanum* occurs in a wild state. This mildew has been recorded on a number of the *Solanaceae*, more especially on the genus *Solanum*, and even on a couple of the *Scrophulariaceae* family. The writer has not had opportunity to study the blight to any extent outside of Connecticut, and, besides the potato, has collected it only on the tomato. Specimens of the latter, collected both in Connecticut and Porto Rico, did not throw any light on the oospores. The question of hosts and distribution cannot, therefore, be discussed on the basis of personal experience. The fifth and sixth suggestions, however, have had our attention during the past two years and may be discussed further.

Are oospores produced in decaying potato tissues? Worthington Smith, of England, was the most prominent advocate of the existence of oospores and claimed to have found them commonly in that country in the decaying leaves and tubers. The Royal Horticultural Society awarded him a gold medal for his alleged discovery. While his investigations were made twenty to thirty years ago, they have never been substantiated unquestionably. At the same time he was at work, DeBary, of Germany, the most able mycologist of his time, was also undertaking a study of the potato disease at the request of the Royal Agricultural Society of England. He was unable to find any positive evidence of oospores and he criticized Smith's work severely and apparently on good grounds. There is no doubt that Smith did not always record accurate observations, and there is little doubt that in his study of the developing "oospores"

he dealt with more than one fungus. The chief question, however, did he have under consideration at any time oospores of this fungus. Unfortunately the writer can give a positive opinion on this question, as he has not Smith's specimens and has so far been unable to confirm results. The drawings he gives of the mature spores in book (6) resemble such spores, but other of his drawings questionable. But even DeBary (2) does not deny that some of the bodies Smith described might have been oospores, for he says, "The warty bodies are possibly its oospores." In another place in this same article DeBary also says: "Ever since oospores of a *Peronospora* were discovered, innumerable searches have been made for those of *Phytophthora*. I myself looked for them in the stalks, leaves, flowers, fruit tubers of the potato. In July of the present year (1875), when the fungus appeared in this district in sad abundance, I obtained a very large amount of material for study and at the same time secured the kindly assistance of two botanists experienced in researches of this kind, Dr. Rostafinski and Dr. Stahl. Again only negative results were arrived at." Since Smith's time, Smorawski and others have claimed to have found oospores, but these claims always lack positive proof. However, most botanists probably believe with DeBary that oospores will be found sometime. He said, "That they will be regularly found somewhere or other is assumed, for our knowledge of the habits of numerous allied fungi make this more than probable."

Smith stated that it was an easy matter to obtain the oospores by merely placing a number of diseased leaves overlapping each other in a moist chamber and examining them as they rot down. The writer has tried his method a number of times and has never succeeded in finding spores that were decidedly suspicious. True, one frequently finds various kinds of rounded, usually isolated, bodies in such leaves, some of which are apparently spores of fungi and others merely encysted stages of the lower animals. Even if one were to find the oospores under these conditions, it would be a difficult matter to accurately trace their development because of probable confusion at times with other things. After considerable search in the dying and dead leaves and stems, it finally seemed to the writer that the diseased tubers offered the most likely place for the formation of

oospores. Consequently these have been searched in all stages of infection and decay and at various times of the year. While some suspicious bodies have been seen from time to time, no very definite evidence has been gained that the fungus produces oospores even here. If they are formed in the tubers it is only in the decayed parts, as the healthy tissue offers little opportunity for their development and no suspicious signs have been found there. Examination of tubers decayed from a dry reddish brown rot usually shows the presence of the peculiar short haustoria of the blight fungus and these seem to become more prominent and develop thick, swollen walls with the advance of the decay. Often two of these haustoria are seen standing side by side in a cell, and while they indicate a living mycelium, even in advanced stages of rot and disintegration of the tuber, nothing definite concerning any further development of them or the mycelium has been made out. Resting spores with thick walls and somewhat of the type of oospores have been seen, but there was never any evidence that they were formed from the mycelium of the blight fungus. The potato tuber before its final dissolution in the ground is the workshop of many different fungi, as well as of the lower animals, hence the necessity of caution in forming *decided* opinions of forms found there. These tubers finally, through the work of the animal life, are more or less scattered through the soil, so that if oospores are formed they would secure more or less of a local distribution in the soil, probably about the time the blight appears in the fields.

Mycelial strains. In recent papers Blakeslee* has shown that in a related family, Mucoraceae, certain species possess mycelial strains, apparently of a sexual nature, that produce zygospores only when these grow together. Securing artificial cultures of the two strains, which he calls + and —, of such a species, he was able to produce the zygospores at will merely by inoculating the same cultural tube with both forms. In the study of various downy mildews it has occurred to the writer that possibly similar conditions are true for certain of these fungi, and in our Report for 1904 this was suggested as a possibility for the

* Science, 19: 864-6. 1904. Proc. Amer. Acad. Arts Sci., 40: 203-321. 1904.

potato mildew. Some effort, as stated previously, has been made to secure such strains in pure cultures and prove the theory by cross inoculations, but as yet no evidence has been secured in this way. While no positive proof has been gained for this belief, there are yet certain facts, as given in the next paragraph, that may be considered at least favorable to it.

In the first place the oospores of the Peronosporae, like the zygosporae of the Mucoraceae, are not commonly found in nature. There are species, other than the potato mildew, for which they have never been found; others for which they have been rarely found; some for which they have been found only on certain of their hosts; and finally, some in which they are not uncommon if looked for at the proper time and place. All of these facts are in favor, rather than against, distinct mycelial strains (heterothallic forms) except the last, which might indicate a homothallic form (one which contains both antheridia and oogonia on the same mycelium). Secondly, our culture experiments with the Lima bean and potato mildews, both species of *Phytophthora*, is in accord with this theory. The potato mildew cultures never produced oospores under any condition, possibly because there was but one strain present, and our cultures of the Lima bean mildew ran to the production of oospores, possibly because the cultures were obtained from material containing both strains. The potato mildew cultures often gave a very evident aerial growth of the mycelium and conidiophores, while this development in cultures of the Lima bean mildew was usually inconspicuous, though in nature its conidial stage is much more prominent than that of the potato mildew. Thirdly, Smith, in a drawing of the development of his supposed oospores of the potato mildew, shows two different mycelia side by side, one producing oogonia and the other antheridia. DeBary at first criticized this on the ground that the oogonia and antheridia were not on threads in anatomical relation with each other, but later, according to Smith, withdrew this criticism. Smith, of course, may have shown in this drawing something having no connection with the potato mildew, yet in all of the drawings, seen by the writer, of DeBary (1) and others showing the development of oogonia of various mildews, the antheridia and oogonia are always figured on threads having no connection with each other. It is true that only a

short piece of each thread is shown in these drawings, but it is usually difficult to trace these further. In our study of the Lima bean mildew effort was made to follow these threads as far as possible, and the evidence, so far as obtained, pointed to their independent origin, so that they could easily have been borne on two different mycelia closely interwoven.

Delayed appearance of blight. It is not as yet definitely known why the blight does not appear earlier in the potato fields. The weather in May and sometimes in early June is as favorable for its development as that of July and August, when it does first appear. On the face this would indicate that the germs for infection were not generally available so early in the year, and yet this is the very time when the mycelium* in the seed tubers underground is best situated for producing the conidial stage on them. DeBary possibly explains this delayed appearance in the following statement: "From large experience I consider it probable that *Phytophthora* grows more easily on a plant at the height of its development than on young stalks and leaves. It would be interesting, but not easy, to establish this clearly by experiment." In the writer's experiments already given it was found possible to easily infect young leaves and stems, but whether the subsequent development of the fungus was more or less vigorous than on old tissues was not a point at issue. Possibly the point previously suggested in this article explains the late appearance; viz., that the mycelium from primary infections on young, rapidly growing tissue remains localized until after vegetative growth of the host ceases and then renews its activity on the appearance of favorable blight weather. If the primary infections, however, usually take place, as the writer believes, by contact of the leaves with the ground, this is best accomplished in the full grown plants. The young plants are rigid and shoot straight up out of the ground, and by the time they have attained any

* According to DeBary's and our experience the *mycelium* will produce its conidial stage only in the living tissues of the tubers, but Massee, on the other hand, reports this stage in the old diseased tubers even a year after they have rotted; if the fruiting stage found by him was developed by the germination of *oospores*, this apparent conflict of observations might be explained.

considerable growth and are likely to lop over on the ground, the wet weather of the spring is largely past. If it were known definitely that oospores were produced, the most feasible explanation would be that these did not germinate until the wet weather of July and August and then their zoospores in the moist earth infected the leaves that were washed down in contact with them by the rains. This would agree perfectly with what the writer has been able to ascertain so far, of the primary infections in the fields.

LITERATURE.

The botanical and general agricultural literature dealing with the potato mildew is perhaps more extensive than that for any other fungus. There are given here merely a few articles, to which reference has been made in the preceding discussions.

1. **DeBary, A.** Recherches sur le développement de Quelques Champignons Parasites. Ann. Sci. Nat. Bot. IV, 20: 5-148. 1863. [Illustr.]

Deals in this paper especially with the Peronosporae and gives considerable information, with illustrations, of the potato mildew.

2. **DeBary, A.** Researches into the Nature of the Potato Fungus, *Phytophthora infestans*. Journ. Bot., n. s., 5: 105-26, 149-54. 1876. [Illustr.]

Gives in this excellent paper the life history of the fungus, so far as known, and treats especially of his studies made for the Roy. Agr. Soc. of England and a criticism of Worthington Smith's so-called oospores.

3. **Massee, G.** Diseases of the Potato. Journ. Roy. Hort. Soc., 29: 139-41. 1904.

Gives short general account of the mildew and makes two recommendations, based on field and laboratory observations, for keeping it in check; namely, collection of the diseased and old seed tubers at harvest time and use of seed tubers showing no sign of disease.

4. **Matruchot, L. and Molliard, M.** Sur la culture pure du *Phytophthora infestans* DeBary, agent de la maladie de la pomme de terre. Bull. Soc. Myc. Fr., 16: 209-10. 1900.

Note that they have been able to grow this fungus on living and sterilized media in pure and artificial cultures.

5. **Matruchot, L. and Molliard, M.** Sur le *Phytophthora infestans*. Ann. Myc., 1: 540-3. 1903.

Give further more extended notes on the artificial cultures of this fungus on living and sterilized slices of potato and pumpkin;

note that the fungus does not discolor the living plugs of potato if grown pure; found no oospores.

6. Smith, W. G. Potato Disease, I, II. Diseases of Field and Garden Crops: 275-329. 1884. [Illustr.]

Makes an extended report on *Phytophthora infestans* in both its active and passive state; discusses in detail his discovery of oospores.

7. Smorawski, J. Zur Entwicklungsgeschichte der *Phytophthora infestans* (Montagne) DeBy. Landwirthsch. Jahrb., 19: 1-12. 1890. [Illustr.]

Gives a general account of the investigations of others and records observations and experiments of his own; describes and illustrates immature oospores that he connects with this fungus.

8. Wilson, A. S. Potato Disease and Parasitism. Trans. Proc. Bot. Soc. Edinburgh, 19: 656. 1891.

Explains his mucoplasm theory, by which he accounts for the spread of the blight.

Apple.



a. Fruit Speck, p. 264.

Lima Bean.



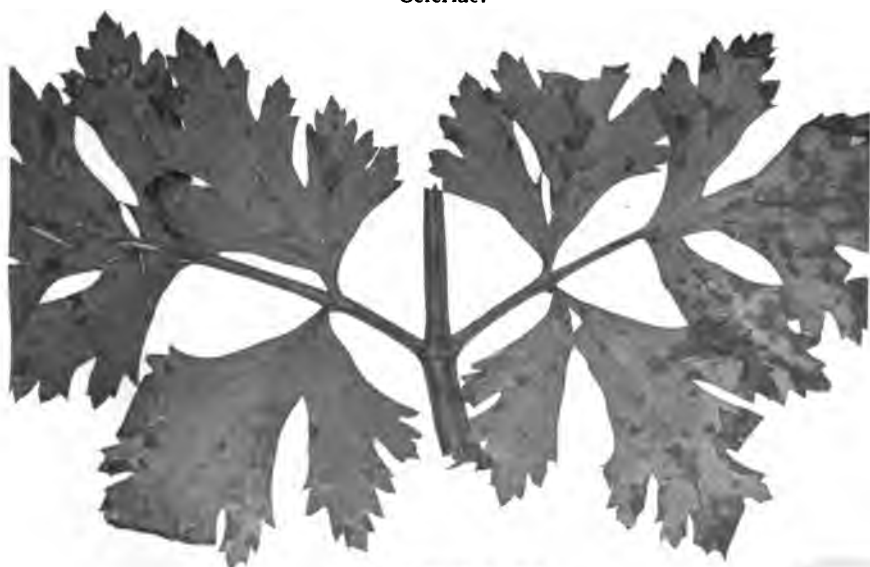
b. Leaf Blight, p. 265.

FUNGI OF APPLE AND LIMA BEAN.



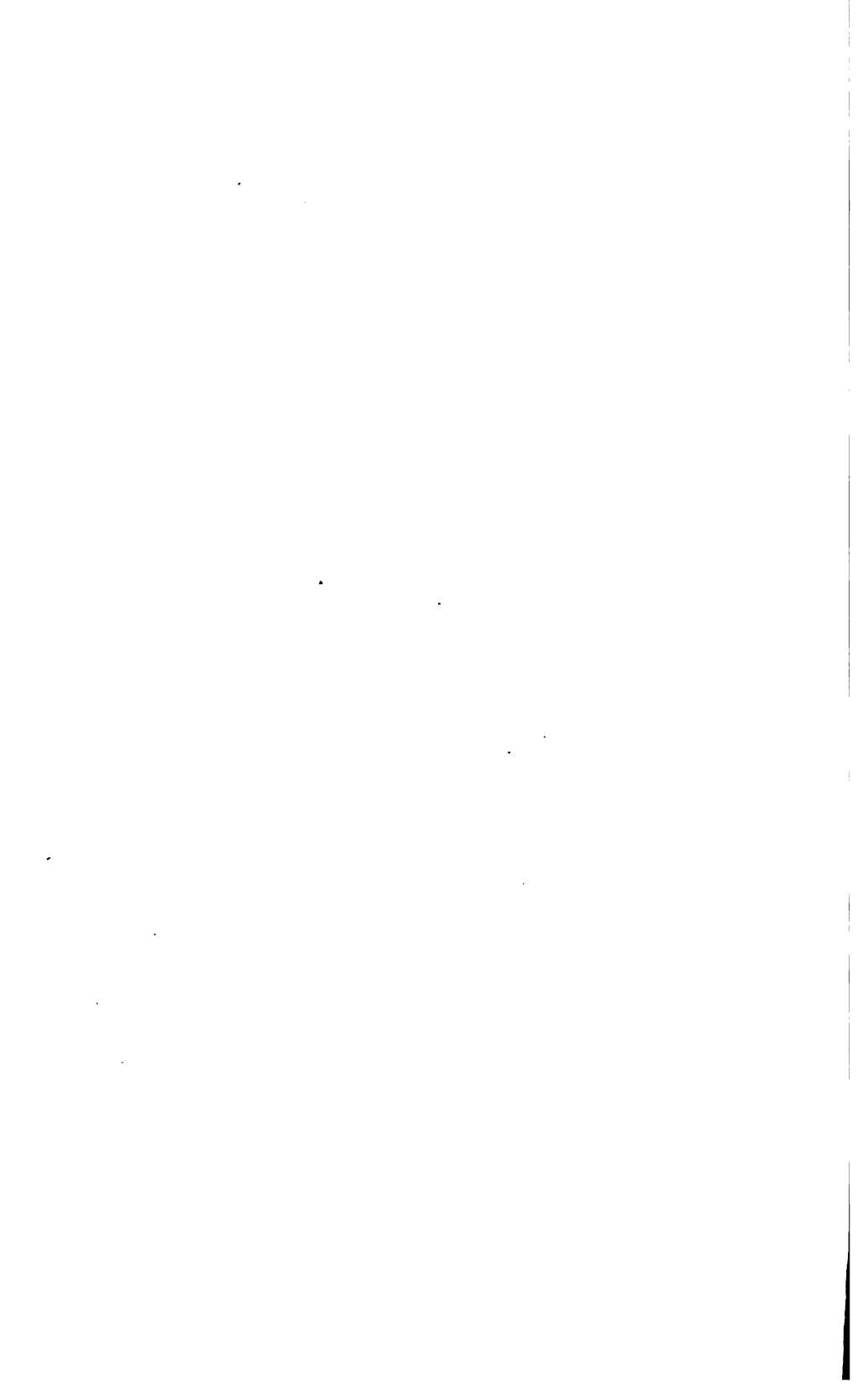
a. Leaf Spot, p. 266.

Celeriac.



b. Leaf Spot, p. 267.

FUNGI OF CATALPA AND CELERIAC.





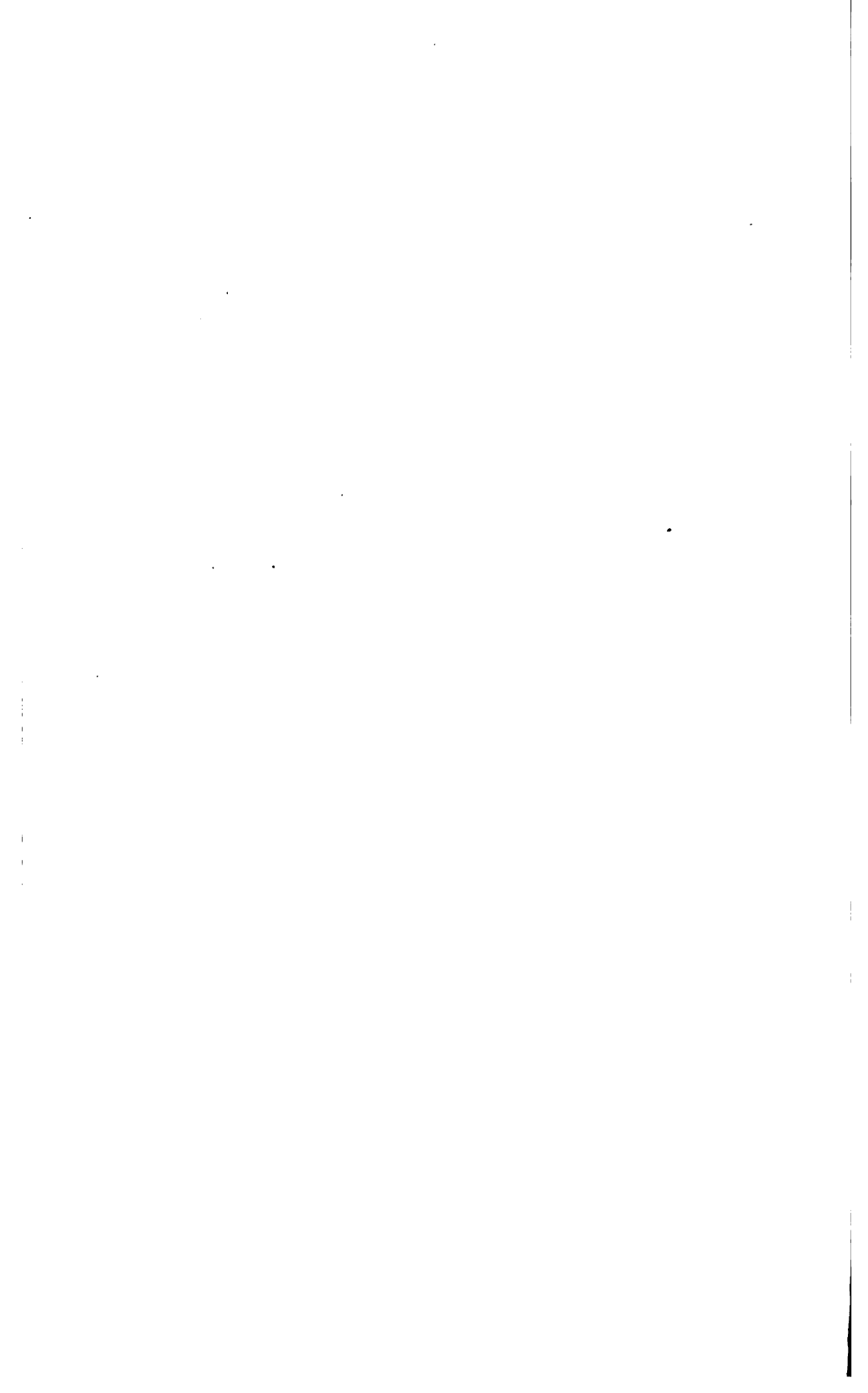
a. Leaf Scorch, a physiological trouble, p. 267.

Nectarine.



b. Scab, p. 268.

DISEASES OF MAPLE AND NECTARINE.

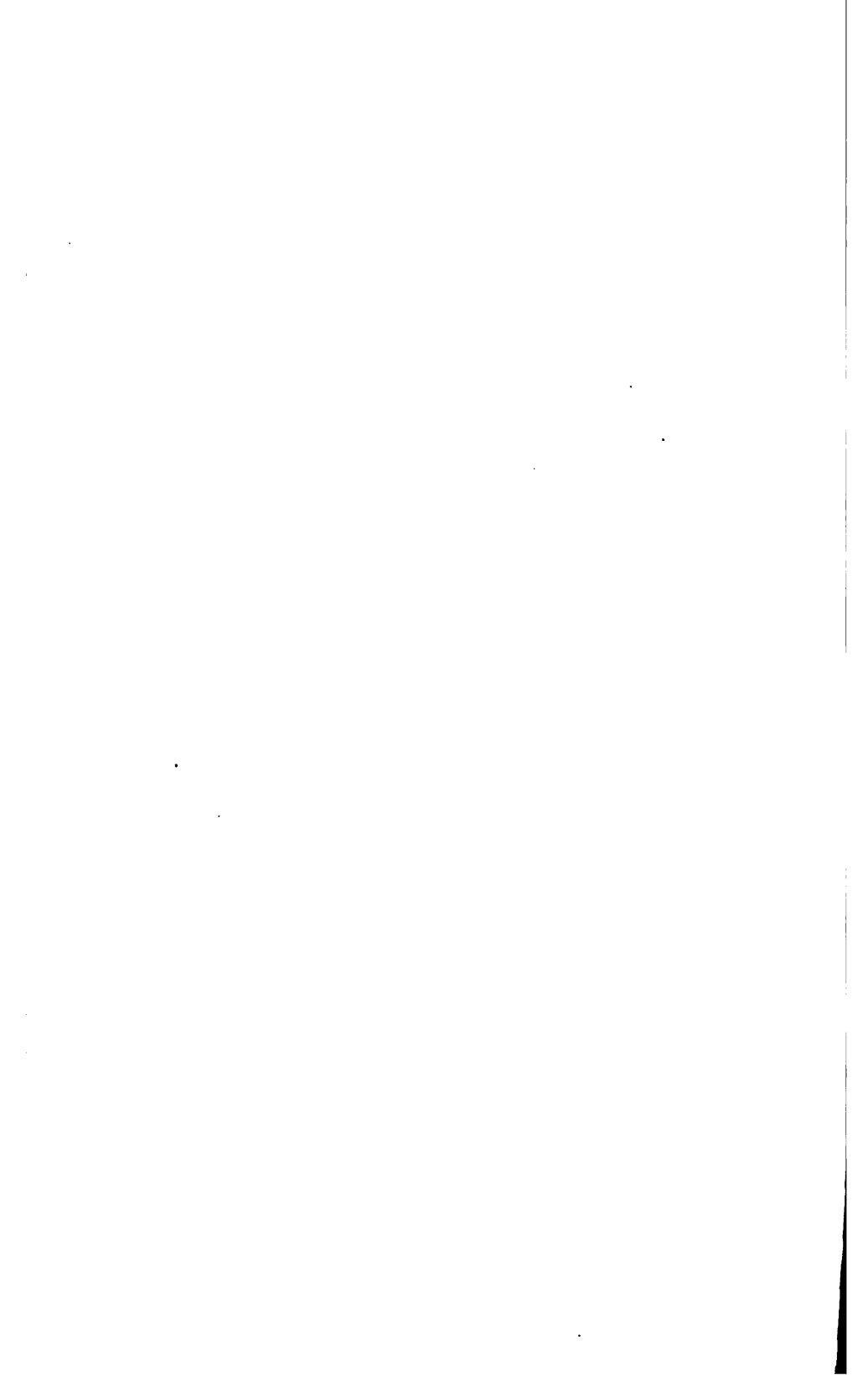




a. Showing upward progress of disease by character of leaves.

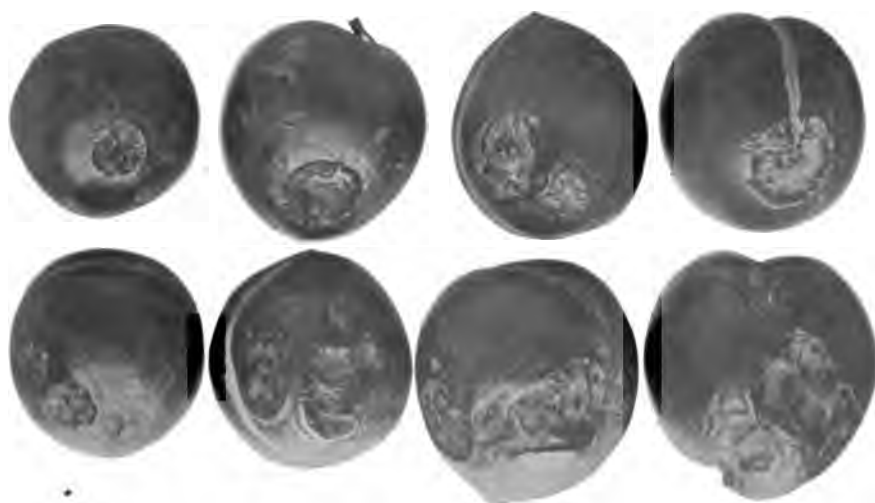


b. Longitudinal and cross sections of stems, showing how tissues are injured.



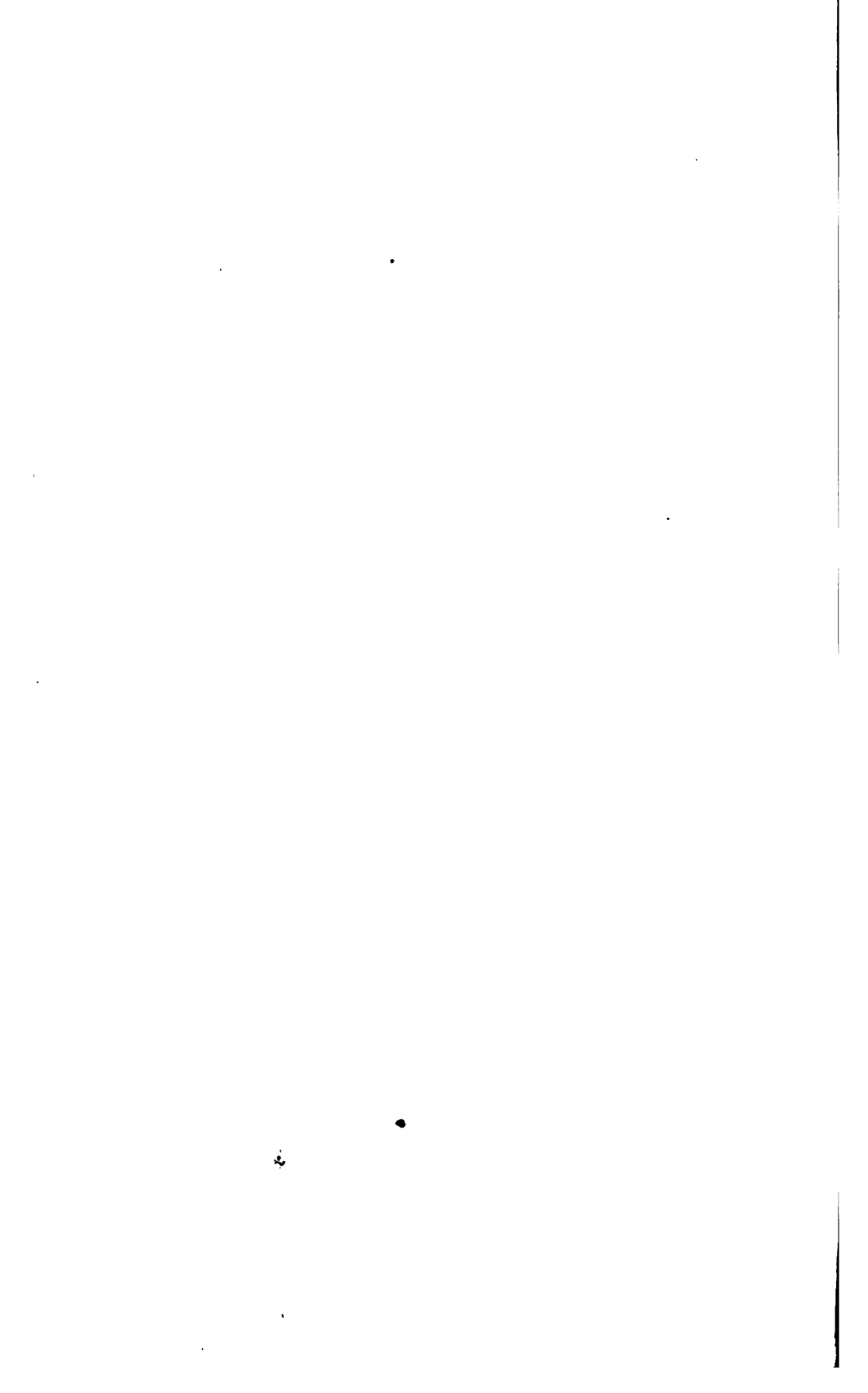


a. Onion Brittle, showing peculiar malformation of leaves, p.270.



b. Bacterial Black Spot of Plum, p. 273.

DISEASES OF ONION AND JAPANESE PLUM.





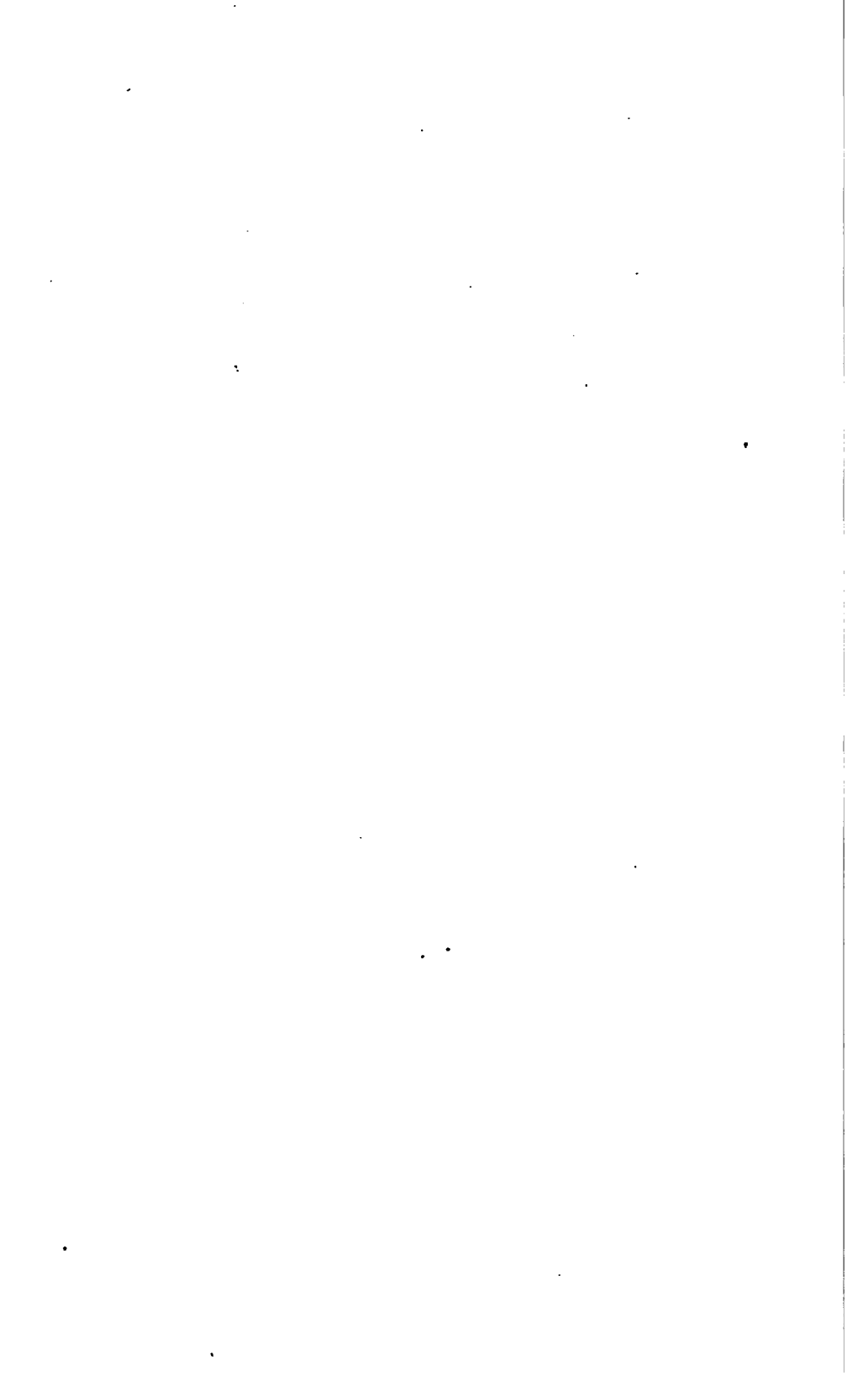
a. Leaf Mold, p. 275.

Strawberry.



b. Powdery Mildew, p. 276.

FUNGI OF SPINACH AND STRAWBERRY.

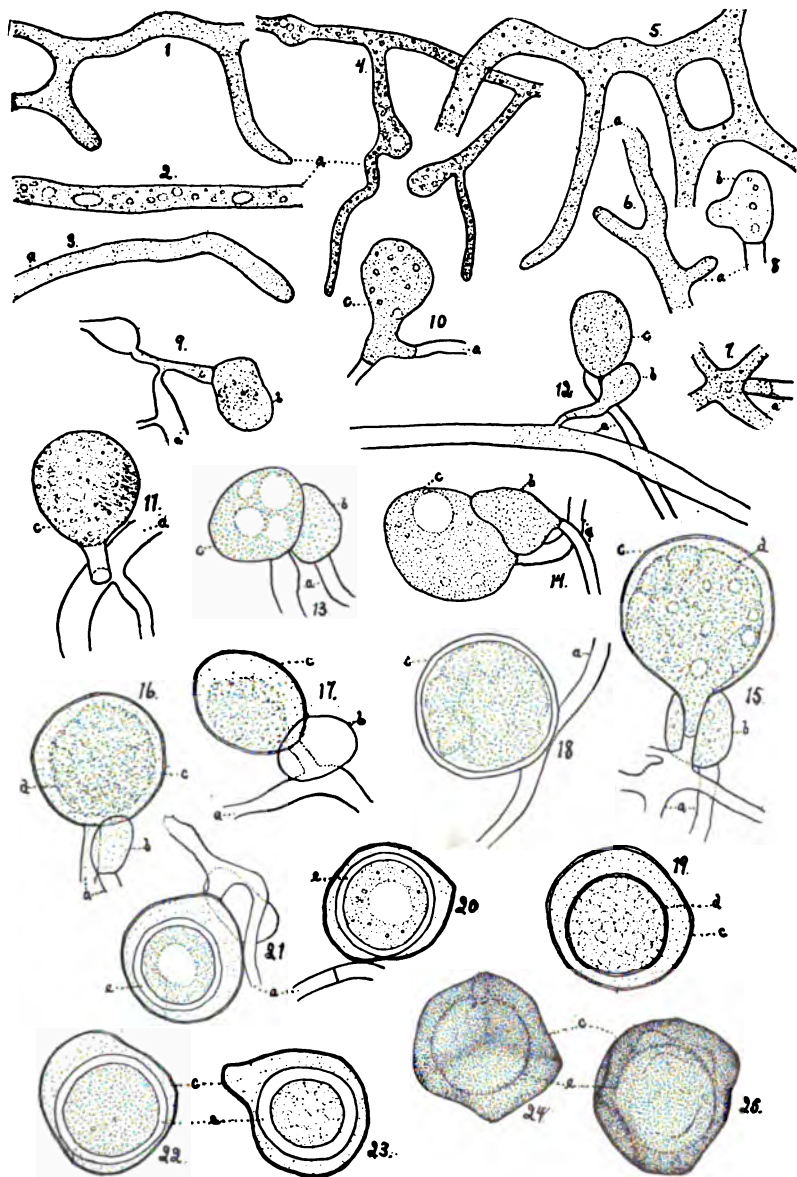




a. Cultures of the fungus on potato agar, showing sclerotia.

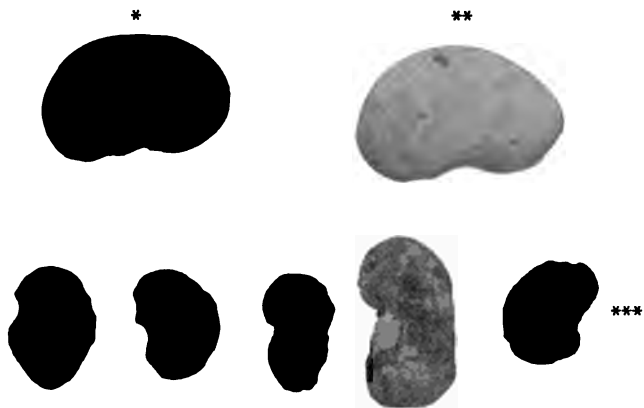


b. Showing how the fungus injures base of stems.



a, mycelium; *b*, antheridium; *c*, oogonium; *d*, oosphere; *e*, oospore. Figs. 1-7, showing character of mycelium. Figs. 8-21, antheridia and oogonia and their development. Figs. 22-25, mature oogonia and oospores. Magnified about 600 diameters.

DEVELOPMENT OF MYCELIUM AND OOSPORES OF LIMA BEAN MILDEW,
Phytophthora Phaseoli.



a. Diseased seed containing oospores, except healthy one at **, pp. 292, 297.



b. Showing injury to young stems and leaf, p. 281.

DOWNY MILDEW OF LIMA BEAN, *Phytophthora Phaseoli*.





a. Showing mildew in young and old state on pods.



b. Showing portion of infected pod enlarged two diameters.

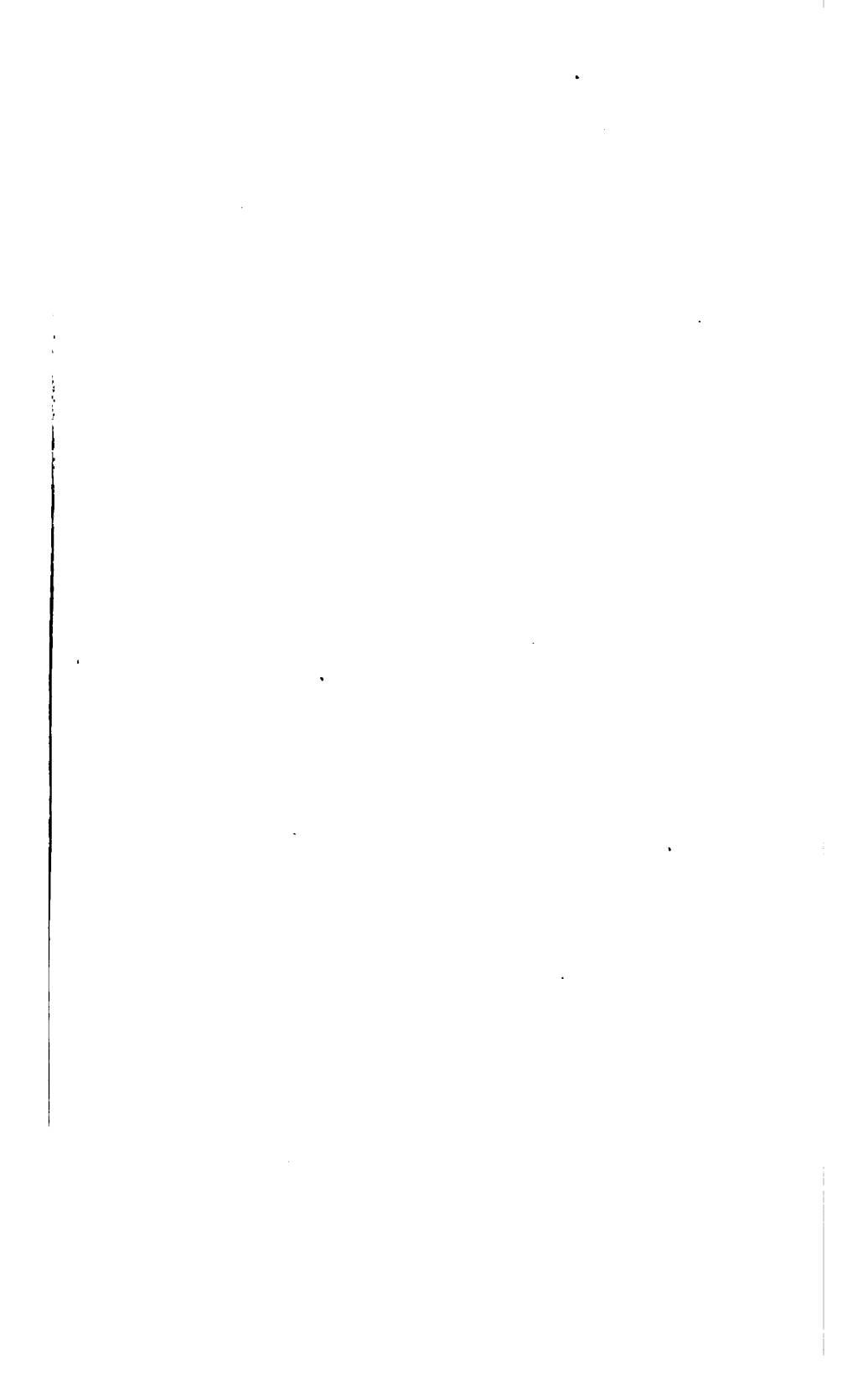


a. Showing primary infection from contact with ground, p. 309.



b. Artificial infection of the mildew on cut surface of tuber, p. 318.

DOWNY MILDEW OR BLIGHT OF POTATO, *Phytophthora infestans*.





a. Two lower and tip of third leaf killed by fungus, 10 days after inoculation, p. 315.



b. Central diseased shoot grown from an inoculated tuber, p. 307.

INFECTION EXPERIMENTS WITH *Phytophthora infestans*.





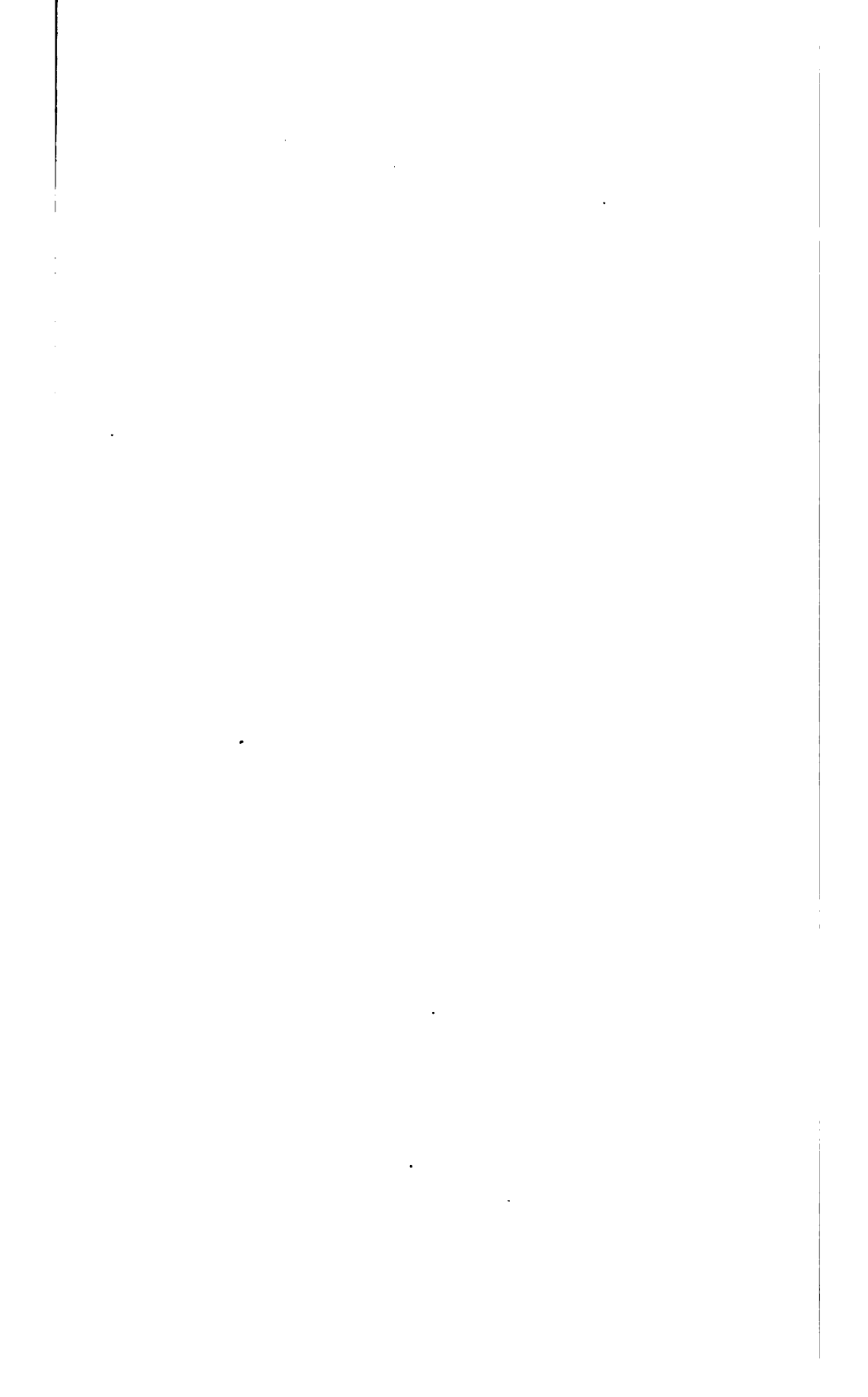
a. On plugs of living potato. a, check.



b. On corn meal.



c. On pumpkin agar.



PART VI—(CONCLUSION).

Tobacco Breeding Experiments in Connecticut.

BY A. D. SHAMEL.

*Of the Bureau of Plant Industry, U. S. Department of Agriculture, in
Coöperation with the Connecticut Agricultural Experiment
Station, New Haven.*

Introduction.

The experiments on the improvement of tobacco by breeding and seed selection carried on by the Bureau of Plant Industry of the United States Department of Agriculture in coöperation with the Connecticut Agricultural Experiment Station, the past season, have included the continuation of certain experiments begun in 1903, together with others begun in 1904 and 1905. This report presents a brief review of some of the results obtained from these investigations, the details of which, together with a more complete record of these experiments, will be found in the publications of the Bureau of Plant Industry and separate bulletins of the Connecticut Agricultural Experiment Station.

The practical value and importance of these tobacco breeding experiments can best be shown, perhaps, by concrete illustrations of increased profits to the growers by reason of greater yield or improved quality of the crops, obtained by systematic breeding and seed selection.

The production of strains of Connecticut Havana seed tobacco bearing one more leaf on every plant than plants of the present varieties would mean an increased yield of about one hundred pounds of cured tobacco per acre, which, other things being equal, would give the grower an additional return of about fifteen dollars. This increase would be practically all profit, because it costs little more to grow plants bearing a large number of leaves than plants bearing but few leaves. The modification and improvement in the size and shape of

leaves by seed selection and breeding, particularly in the production of strains of plants bearing broad, round leaves, with fine veins standing out at right angles to the midribs, and with uniform texture from the tip to the base, make it possible for cigar manufacturers to cut more wrappers from every leaf than they can cut from the large, long and rather pointed leaves borne by the plants of the present varieties. This increased number of wrappers which can be cut from the individual leaves is bound to result in higher prices to the grower, so that such improvement is beneficial to both grower and manufacturer. In strains where the large and destructive sucker branches have been bred off the plants by systematic seed selection, the lessened cost of growing the crop by reason of the lessened expense of suckering, as well as the better quality of leaves produced by such plants, is additional evidence of the importance of this line of work. The most important phase of this subject, however, is the production of seed which will yield plants of uniform quality, in this way increasing the yield of the more valuable grades of tobacco and reducing the cost of sorting.

It costs but little, if any, more to grow uniform plants producing a desirable type of tobacco than to grow plants lacking uniformity and yielding but a small proportion of the best grades. When such uniform strains, adapted to his conditions of soil and market demands, can be secured by every grower with little or no extra expense, by seed selection, it certainly devolves upon every grower to give this matter earnest attention.

The Practice of Sprouting Seed.

It is a common practice of tobacco growers in Connecticut and other northern tobacco-growing sections to sprout a part, at least, of the seed used for sowing the seed beds. This is usually done by mixing the seed thoroughly with moist rotted apple-tree fibre, or "punk," or rotted cocoanut fibre, and keeping this mixture in glass jars or pans in a warm room for a few days. When the sprouts begin to appear, an equal amount of dry seed is added to the sprouted seed, and the mixture sowed in the seed bed. The reason urged by the growers following this practice for sprouting the seed is that the

sprouted seed apparently produces the earliest seedlings for transplanting.

In experiments conducted to compare plants raised from dry and sprouted seed, the results of these exact comparisons did not support the conclusion that the sprouted seed produced the best plants. It is true that the sprouted seed under *favorable* conditions produced the earliest plants for transplanting, but upon following the plants raised from the sprouted seed, from the seed bed to the field, it was found that the plants raised from the dry seed quickly overtook the plants raised from the sprouted seed, and eventually produced the best developed plants.

In many cases where the sprouted seed was sowed in the seed beds, a slightly unfavorable condition, such as hot sun, or a dry surface of the seed bed, seriously injured, if not entirely destroyed, the tender young plants. The young plants from the dry seed were more hardy and able to withstand the injurious effects of slightly unfavorable conditions. When the seed is mixed with the sprouting medium, either "punk" or cocoanut fibre, it is a common practice to shake or stir the material frequently so as to give as uniform conditions as possible under the circumstances for sprouting all of the seed. However, it frequently happens that some of the seed, most favorably located, produces long sprouts before it is sowed in the seed beds. These plants are liable to injury in sowing, and such injuries are likely to result in inferior, dwarfed and undesirable plants.

Whenever the condition of the soil permits, the dry seed can safely be sowed several days earlier than the sprouted seed, and with this advantage will, in most cases, produce as early, if not earlier plants, for transplanting, as the sprouted seed. In the case of hot-beds, whether warmed by manure, steam, hot water, or other means, there is no good reason for sprouting the seed before sowing, and the practice is not only unnecessary and somewhat expensive, but, as pointed out in the preceding paragraphs, likely to seriously injure the development of the tobacco beds.

It is recommended that growers demonstrate the matter for themselves by sowing this year a portion of the seed bed or beds with dry seed, that is, without any sprouted seed, in order to make a comparison of the two methods of sowing seed. It

can be safely said that the dry seed will produce better plants in the field than the sprouted seed, and if proper methods of sowing are pursued, will produce equally early plants for transplanting.

Seed Separation.

Large, heavy tobacco seeds produce the best plants. As a rule, the large seeds begin to germinate more slowly than those which are small, light, or immature, but after they begin to develop, the young plants from the heavy seed make rapid and vigorous growth. At the time of harvest, the plants grown from heavy seed are usually several days earlier than the plants from the light seed. This difference in rate of growth becomes more apparent as the season advances, although in seasons very favorable for plant growth plants from light seed seem to overcome, in part at least, the unfavorable conditions of growth of the fore part of the season. On the whole, however, the observations of the writer in the comparison of plants raised from light and heavy seed have shown that the heavy seed produces the earliest, most productive and valuable tobacco plants.

The small, light, and particularly the immature seeds tend to produce irregular, so-called "freak plants," which, in some cases, at least, are more subject to the attack of fungous and other diseases than normal healthy plants. In view of the fact that the light seeds sprout earlier than the heavy seeds, it is probable that many of the plants grown from such seed are set out in the field by the growers and are responsible for a part, at least, of the undesirable plants in the field. The mosaic or calico disease, which, according to the best evidence obtainable, is due to faulty nutrition, affects plants raised from light and immature seed more extensively than plants raised from heavy seed. In Connecticut in the past season, certain crops raised from heavy seed were almost free from calico, while adjoining crops raised from the same variety of seed but not separated, and under very similar conditions of culture, contained from 15 to 40 per cent. of calico plants. The same facts have been reported from other tobacco-growing regions. For instance, in the tobacco-breeding experiments conducted by the Bureau of Plant Industry in coöperation with the Maryland Experiment Station in Maryland, a portion of a certain sample of seed was separated and the heavy seed retained for

planting, while the other portion of the seed was not separated. The plants raised from the heavy seed were almost wholly free from calico, while adjoining rows of plants raised from the unseparated seed contained as high as 60 per cent. of calico plants. It is reasonable to suppose that the thrifty and vigorous plants raised from the heavy seed more easily resist or throw off the attacks of certain diseases or, at least, recover more quickly from the effects of injuries caused by diseases or unfavorable conditions, than the slower growing and weaker plants raised from the light seed.

Owing to the minute size of tobacco seed and the consequent slight differences in size and weight of the light and heavy seed, it has been difficult to effect a practical separation of the light from the heavy seed. It has long been recognized that the heavy seed were in all probability the best for planting, but no simple or practical means was devised for securing the heavy seed. In the course of the experiments in tobacco breeding conducted by the writer, it was early recognized that the invention of a practical seed separator was a matter of great importance to the tobacco grower. After several experiments, a machine was devised which, with subsequent improvements, has proved to be admirably adapted for this purpose. A picture of this machine is given in Figure 10, and a description of it can be found in the Yearbook of the Department of Agriculture for 1904.

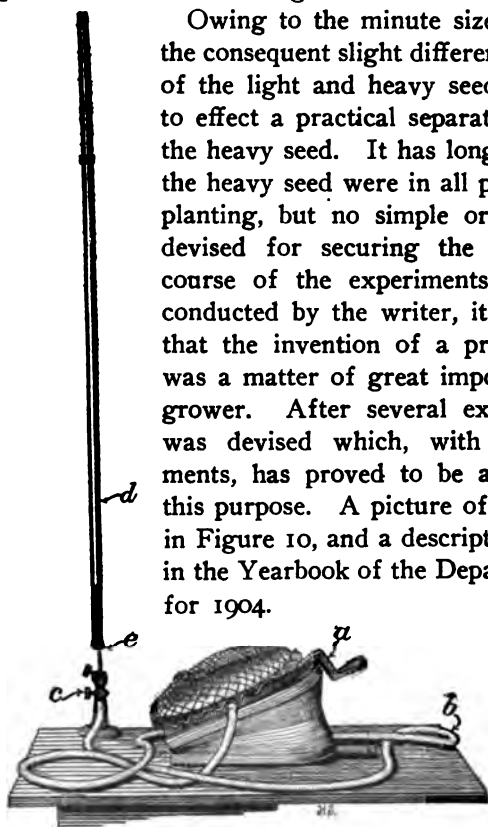


FIG. 10. Tobacco Seed Separator.

Following the invention of this machine, other seed separators, some of which doubtless are improvements, in some respects at least, upon this sep-

arator, have been devised by tobacco growers in Connecticut and elsewhere. One of these, invented by Mr. D. P. Cooley of Granby, Connecticut, has come into general use and proven to be very satisfactory for the purpose.

The small bulk of tobacco seed required to sow the seed beds makes it a small and inexpensive matter to separate the seed even for the most extensive plantations. In view of the important and profitable results obtained as a result of this attention, it is incumbent upon every grower to carefully separate out the heavy seed for planting and discard the light and inferior seed.

The Value of Self-fertilized Seed.

Inbred or self-fertilized tobacco seed, like the seed of certain other exotic plants, produces better plants than seed which has been cross-fertilized within the variety. Under natural conditions, tobacco flowers are frequently cross-pollinated by bees, insects of various kinds, humming birds, and other agencies. These flowers secrete a sweet, honey-like substance at the base of the corolla, which, at the time the flowers open, falls like drops of rain about the plants when the plants are shaken. Bees and other insects feed upon this nectar, which they secure, as a rule, by crawling down the inside of the flowers. As the insects pass in and out of the flowers, in the course of their visits from flower to flower and plant to plant, they carry about with them the pollen adhering to their bodies, in many cases, no doubt, cross-pollinating the flowers that they visit in search of food. In this manner, the flowers on the plants saved for seed may be crossed with an inferior plant, or with the plants of other strains of varieties of tobacco grown in the vicinity. This cross-pollination is doubtless effected in some cases between fields of tobacco situated several miles apart, but most frequently occurs between plants in the same field. Such cross-fertilized seed produces plants which, as regards uniformity of type, vigor of growth, and quality of leaf, are inferior to plants raised from the seed of carefully selected plants protected from cross-fertilization.

This striking and important characteristic of the tobacco plant makes it possible for the grower to select the type of plant he desires, that fulfils his ideal of a good type of plant, and, by protecting the flowers of this plant from cross-fertilization, to propagate this valuable type in succeeding crops. No one thing in the course of these experiments has stood out so clearly as the wonderful uniformity of the progeny of plants the seed of

which has been saved under bag and thus protected from cross-fertilization. The reason that this characteristic of strong transmitting power is so striking and makes such a strong impression on the observer is because the characteristics that are important in the production of a high grade cigar wrapper tobacco, such as size and shape of leaves, number of leaves and suckers borne by the individual plants, size and arrangement of veins, and color of leaves, are prominent and can be easily noticed even by the most casual observer. Therefore, in looking over a row or plat of plants, the progeny of a parent whose flowers were protected from cross-fertilization,—a row or plat in which every plant is alike, the number, shape and size of leaves the same, the height of plants, number and size of suckers alike, the color of leaves and size of veins uniform as regards every plant,—the observer must be forcibly struck by the faithfulness with which the characteristics of the parent plant have been transmitted to all the progeny. Of course, the season, the system of culture and other factors exert a strong influence on the crop, but, in any case, the effect of using self-fertilized seed and the benefits to be derived from following the practice of saving seed in this manner are plainly evident under all conditions.

The Selection of Seed Plants and Methods of Saving Seed.

The selection of the plants to be saved for seed production requires careful study of the individual plants in the field from the time of transplanting to the topping process. In order to illustrate the necessity for the careful observation of the plants used for seed production during the early as well as later stage of growth, the selection for early maturing strains may be cited. The difference in earliness between individual plants is more noticeable in the young plants than in the older ones. In Plate XXVI, a, is shown an illustration of the great variability in rate of growth, correlated with earliness and lateness of ripening of the tobacco on different plants of Connecticut Broadleaf tobacco. In previous experiments it has been demonstrated that by selecting the early plants,—such as the large early plant in the illustration,—and saving the seed under bag,—it is possible to produce an early maturing strain of tobacco, a matter of great importance in northern sections. This difference in rate

of growth and earliness of maturing is not so easily noted when the plants are nearer maturity.

In the case of the Havana Seed and Broadleaf varieties of tobacco, the ideal type of plant is one producing the largest possible number of leaves consistent with good curing and other considerations of handling the plant. The leaves should be broad and round, with fine veins standing out at almost a right angle with the midrib. The texture of the leaf should be uniform from the tip to the base so that as much of the leaf as possible shall be available for cutting out cigar wrappers with the least possible waste. The leaves should be uniform from the top to the bottom of the plant in shape, size and all other characteristics, more particularly in time of ripening. The plant should have but few and small suckers, and the leaves should be set very closely together on the stalk. These characteristics will usually be found to be correlated with small production of seed.

With a clear conception of the type of plant desired, the grower should carefully study the plants in the field in order to pick out the plants most nearly approaching the desired type and to save them for seed. When a plant is found that at a preliminary examination seems suitable for seed production, it can be marked with a rag or some kind of tag. During the topping process these plants must be marked very prominently in order to avoid accidental topping. As soon as the flowers begin to develop, the plant should be pruned for the application of the bag.

In preparing the plant for the bag, all of the top leaves and sucker branches should be carefully pinched, or better, trimmed off with a small pair of scissors or with the pocket-knife. This process is most important, because if the top leaves are allowed to grow within the bag, the water constantly transpired by them favors the development of mold within the bag and the injury of the seed by it. Neglect of this detail has been the most fruitful cause, in fact, so far as the writer is aware, the sole cause of poor seed under bag. The writer has lost hardly a single head of seed from thousands of seed heads saved under bag.

The best kind of bag is a very light but strong paper bag, of at least twelve-pound size. If desired, needle holes can be punched in the bag, although so far as the writer knows there

is no reason for so doing. In no case should heavy coarse bags be used, because they absorb moisture, dry out slowly, and by their heavy weight tend to bend and in some cases injure the plant.

The bag should be put on before any flowers open, or if any of the flowers open before the bag can be applied, they should be pinched off and discarded. The bag should be tied loosely about the stalk below the flower head and slipped up occasionally to allow for the rapid development of the growing stalk. During the past season, the writer observed one or two cases out of the many "bagged" fields where the growers had put on the bag, then carelessly left the plants, never touching them again until ready to harvest the seed. As a result, the big sucker developed in the plant, appropriating the nourishment that otherwise might have gone to the production of better seed, and in some cases suckers growing within the bag simply pushed out through the bottom of it, in the meantime crushing and injuring, if not wholly destroying, the seed pods in the bag.

After the seed has been fertilized and the pods have begun to swell, the bags can be removed, if desired. Such practice may be advisable, particularly during a long damp season, but is not recommended as a rule. The writer does not remove the bags at all, and for three seasons, with a little attention and care to every plant, has had no difficulty in getting the normal supply of excellent seed. If the bags are removed, all the flower buds and every flower not yet fertilized must be carefully picked off and thrown away.

Plate XXVI, b, shows a field in which high-bred tobacco seed is being grown on a commercial scale, by the method just described.

When the pods have turned brown, indicating maturity, the seed heads should be cut off, hung in a dry, airy place, and allowed to dry out very thoroughly. As soon as completely dry, the seed can be shelled, the light seed blown out with a seed separator, and the heavy seed stored in dry glass jars placed in a safe place. Under such conditions the vitality of tobacco seed will remain almost wholly unimpaired for a considerable term of years.

If the grower wishes to breed tobacco more carefully, the leaves from the seed plants should be picked off when they

become ripe, and the leaves from each plant strung on a separate lath, so numbered as to correspond with the seed head of the same plant. These laths of tobacco should be hung in the curing shed, under normal conditions, and sweat with the bulk of the crop. A study of the cured tobacco may reveal characters and qualities undiscovered in the green leaves in the field. The seed from the plants producing the best tobacco can then be used for planting, and the seed from the plants producing the poor tobacco discarded. This method of selection is of particular value and importance where the selections are made on the basis of burn, as it enables the grower to pick out the plants producing good burning tobacco. The test for burn can be made in the usual manner or with apparatus described in a bulletin of the Bureau of Plant Industry which is in course of preparation. The usual test with a match, or wrapping on a cigar, however, will suffice, under ordinary circumstances, for the making of an intelligent selection.

Two New Varieties Produced by Hybridization.

In the season of 1903 the writer made a number of crosses of varieties of tobacco, in one case using Connecticut Havana as the mother parent, and Cuban, Sumatra, Broadleaf and other varieties as male parents. In another set of crosses the Connecticut Broadleaf was used as the mother parent, and Cuban, Sumatra, Havana Seed and other varieties as male parents. In 1904 the progeny of these crosses were planted in separate rows or plats in experimental fields. In 1905 selections of seed from the best plants produced in 1904 were set out in separate rows or plats, from which seed was obtained for general distribution in 1906. As a result of these crosses, two hybrids have been secured of particular merit and value, possessing the acclimated and high qualities of the native New England varieties, combined with some of the finer qualities of the standard imported varieties. Other new types were secured which give promise of being of value, but, in order to fully demonstrate their possibilities, further careful tests in the experimental field are necessary. The two varieties which have been considered fixed and worthy of distribution are to be considered simply as improvements on the native New England varieties. They are adapted to the same methods of culture, harvesting

and handling in the curing sheds and warehouses, in fact, are simply modified strains of the Havana Seed and Broadleaf varieties. The general characteristics of these hybrids are, broad, short, round leaves with fine veins; uniform quality and texture of leaf from tip to base; large number of leaves borne by the individual plants; fine, light and even colors in the cured tobacco; good, even and regular burn; considerable stretch or elasticity and strength; vigorous growth of plants, indicating as a rule early maturity; and an appearance when wrapped on cigars of a high grade cigar wrapper tobacco.

The Cooley Hybrid.

Havana Seed ♀ × Sumatra ♂

This new variety was obtained by crossing the Havana Seed variety grown by Mr. D. P. Cooley of Granby, Conn. with Sumatra tobacco. The pollen for pollination was obtained from plants grown from Florida Sumatra tobacco seed. This Florida Sumatra had been grown in the Connecticut valley for two seasons and was partially acclimated. Carefully selected plants were used for both the female and male parents, or for dam and sire. Typical leaves from the parent plants are shown in Plate XXVII, a. In this hybrid, little breaking up of type has been observed during the first or second generation, which is apparently contrary to the experience of plant breeders in other lines of work, but agrees with the general experience of tobacco growers concerning the so-called accidental hybrids. However, there has been more or less variation, giving opportunity for selection, which has been carried on rigidly the past two seasons.

The description of the Cooley hybrid in the field is as follows:—number of leaves, 16; length of leaves, 27 inches; width of leaves, 17½ inches; shape of leaves, very round; uniformity of leaves, very good; color of leaves, deep green; spots, none; rust, none; maturity, early; position of leaves, partly erect; height of stem, 29 inches; circumference of stem, 2¾ inches; length of internode, 2 inches; number of suckers, 2; size of suckers, medium to small.

The Cooley hybrid cured tobacco has been pronounced by buyers and manufacturers to be a very greatly improved

Havana Seed tobacco and worthy of careful trial by Connecticut tobacco growers. In order to propagate the variety, the seed of selected plants must be saved under bag in order to prevent cross-fertilization with other tobacco and possible deterioration. A typical plant of this hybrid is shown in Plate XXVIII, a.

The Brewer Hybrid.

Connecticut Broadleaf ♀ × Cuban ♂

The Brewer hybrid is the result of a cross made in 1903 between a mother plant of Connecticut Broadleaf tobacco (grown by Mr. N. S. Brewer of Hockanum, Conn.) and a Cuban plant as the male parent. The pollen for pollination was secured from plants grown for two seasons in the Connecticut valley from seed imported from Cuba. The striking characteristics of the Brewer hybrid are short broad leaves, very fine veins, even grain and texture from tip to base of leaves, large number of leaves borne by the individual plants, partly erect habit of growth of the leaves, and light even color of the cured and fermented tobacco. Typical leaves from the parent plants of this hybrid are shown in Plate XXVII, b. There is no doubt, after most careful inspection by growers and manufacturers, that this variety is a most valuable acquisition to the valuable varieties of tobacco.

The description of the Brewer hybrid in the field is as follows:—number of leaves, 21; length of leaves, 27½ inches; width of leaves, 19¾ inches; shape of leaves, very round; uniformity of leaves, very good; color of leaves, deep green; spots, none; rust, none; maturity, medium to early; position of leaves, partly erect; venation, very fine; height of stem, 42 inches; circumference of stem, 2½ inches; length of internodes, 2 inches; number of suckers, 2; size of suckers, small.

The suckering habit in this hybrid has a tendency to break out in individual plants, but by reason of analogy in the production of suckerless types of other varieties, it is believed that this habit can be controlled, if not eradicated, by careful selection of suckerless seed plants. Seed should always be saved under bag, in order to prevent cross-fertilization with other varieties. A typical plant of this hybrid is shown in Plate XXVIII, b.

EXAMINATION OF BABCOCK TEST APPARATUS.

Pursuant to the requirements of Section 4887 of the general statutes, the station has tested within the year 293 pieces of glass-measuring apparatus for the creameries and dairymen of the state, making the total number tested since the passage of the law, 4067.

There were tested in 1905

	Tested.	Found inaccurate.
Pipettes for cream	4	0
Cream-test bottles	216	0
Milk-test bottles	73	4
	293	4
Percentage found inaccurate in 1901		2.3
" " " " 1902		1.0
" " " " 1903		0.0
" " " " 1904		0.7
" " " " 1905		1.4

TESTS OF GUERNSEY COWS FOR ADVANCED
REGISTRY.

On request of the Guernsey Cattle Club the station has made monthly tests of the weights of milk and butter-fat given by a number of thoroughbred Guernseys entered for advanced registry.

Within the year, the twelve months' tests of nine cows have been completed. The year's records of three of those, as given by the Guernsey Cattle Club, are as follows:

	Pounds milk.	Pounds butter-fat.	Age years.
Washita's Coquette, No. 11492, owned by R. & H. Scoville, Chapinville.....	7632	346	5½
Lodovia, No. 14647, owned by H. B. Tuttle, Naugatuck	4768	279	3½
Lidigia Lenfestey, No. 14642, owned by H. B. Tuttle, Naugatuck	4462	267	2½

The records of the other six cows have not yet been published. Three cows are now under test.

NOTICE BY THE DIRECTOR.

As this report is limited, by order of the State Board of Control, to 375 pages, papers or summaries of the Station's work on the following subjects cannot be printed:—

Tests of the Vitality of Vegetable Seeds, Notices of the work on Corn, Breeding, Forestry, Cover Crops and the Introduction of Alfalfa into Connecticut.



a. Variation in growth of tobacco plants set at the same time, some maturing ten days earlier than others. This is typical of variations found in all fields.



b. Commercial raising of highly bred tobacco seed saved under bag.



- a. Typical Havana seed mother parent on left.
Typical Sumatra male parent on right.
Typical Hybrid leaf in center.



- b. Typical Broadleaf mother parent on left.
Typical Cuban male parent on right.
Typical Hybrid leaf in center.





b. The Brewer Hybrid.



a. The Cooley Hybrid.

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